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Environmental Effect of Fertilizer Combinations on Some Vegetative Growth Indicators of Two Moringa spp. Trees

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Abstract: The experiment was conducted in a Saran-covered greenhouse on agricultural land in Al-Gharraf District, Dhi Qar province, for the 2023-2024 season. The experiment included 10 treatments resulting from two factors: the first factor, the cultivars (Morinca Oliveira and Morinca shua), and the second factor, a fertilizer combination (5 levels) consisting of (0 without fertilizer, 1 g of nano-NPK fertilizer, 2 g of nano-NPK fertilizer, 1 kg of organic fertilizer, and 2 kg of organic fertilizer). The aim was to study the effect of fertilizer combinations on some vegetative growth indicators of two Morinca shua cultivars. The results indicated a significant increase for the Oleifera cultivar in height (165.18 cm), stem diameter (2.7100 cm), leaf area (2238.69 cm2), and dry matter of the vegetative total (19.379 g). The results also indicated a significant increase for the Shua cultivar in number of leaves. 19.11 leaves per plant and lateral branches 4.04 plant branches. As for the fertilizer combinations, the results showed that spraying nano-fertilizer at a concentration of 2 grams of nano-NPK resulted in a significant increase in height (130.56 cm), number of leaves (24.67 leaves per plant), stem diameter (2.2200 cm), lateral branches (4.11 plant branches), leaf area (2503.72 cm^2), and dry matter of the vegetative system (19.312 g).

Keywords: Vegetative, Moringaceae, Moringa spp. Trees

INTRODUCTION

The Moringaceae family contains only one genus, Moringa, which includes 13 species. Moringa is a perennial angiosperm plant. In English, it is called a drumstick due to its long pods. It has several names, such as the tree of life, the tree of ease, and the miracle tree, due to its nutritional, medicinal, and industrial importance, as well as its important role in environmental protection (Lamou et al., 2016). It is successfully cultivated in tropical and subtropical regions and grows best in dry, sandy soils, as it thrives in poor soils. The moringa tree has many benefits, including medicinal and nutritional benefits. It is one of the most popular plants in Southeast Asia and is widespread throughout the world. Its native habitat is the southern foothills of the Himalayas in northwest India (Premi and Sharma 2013; Radovich). Medicinal plants, including the moringa tree, have a significant role in agricultural, industrial(Fadalah,*etal.*,2023), and medicinal production, as medicinal plants are the primary source of treatment. Medical phytotherapy, pharmaceutical industry, cosmetics, pharmaceuticals and food (Al-Dajwi, 1996). Moringa oleifera is a medium to small tree with pinnate leaves in pairs of 2-3, the terminal leaflet is longer, inverted oval, pale green and the lower pair of leaflets is triple. Moringa oleifera flowers in May and the flowers are creamy white with a sweet scent and consist of five united petals. The fruits are triangular pods in cross-section, with a length varying between 15-120 cm depending on the location (Medina et al., 2007). The Moringa peregrine cultivar is one of the most unusual Moringa cultivars. In the favorable growing season, it has large leaflets and a large tuber. In the dry season, the aerial vegetative parts die and the tuber remains alive underground and then grows again when environmental conditions improve. The Moringa peregrine

leaves consist of three pairs of long, thin, pinnate leaflets. The Moringa peregrine flowers are pink and have a fragrant scent. The fruits are pendulous pods that ripen in October. The seed is white, resembles a hazelnut and is called a behen nut, and has a sweet and bitter taste. Moringa peregrine oil was one of the important medicinal oils.

(Foidl et al., 2001). Nano-fertilizers play important roles in plant nutrition, including increasing the activity of photosynthesis processes by increasing the chlorophyll content of leaves, increasing crop resistance to various stress conditions, increasing plant resistance to diseases, maintaining the quality traits of various agricultural crops, improving yields, and reducing soil pollution (Liu et al., 2005). Organic fertilization affects soil properties in general by improving the soil-water-plant relationship, improving the apparent soil density and total soil porosity, and the efficiency of irrigation water use (Shaaban and Okasha, 2007). Organic fertilizers added to the soil are less hazardous to the soil and the environment and provide slow release of nutrients through the activity of soil microorganisms, which work to release nutrients from organic matter, converting them into mineral elements available to the plant. This promotes good plant growth. The objectives of the study were:

1. A phenotypic study of two Moringa tree cultivars and identifying the best cultivars for growth in Dhi Qar Governorate.

2- The response of Moringa cultivars to different fertilizer treatments (nano-fertilizer, organic fertilizer) and their effect on vegetative growth traits, and determining the best fertilizer.

3- Studying the effect of interaction between cultivars and fertilizer combinations on vegetative growth traits.

MATERIALS AND METHODS

The experiment was conducted in a Saran-covered greenhouse on agricultural land belonging to Al-Gharraf District, Dhi Qar Governorate, for the 2023-2024 season. The experiment involved two Moringa tree seedlings, obtained from a private nursery in Baghdad Governorate. Care was taken to select seedlings of similar size and vegetative growth as much as possible. The seedlings were transferred on March 10, 2023, to large pots with a diameter of 24 cm and a height of 26 cm in a sandy-textured soil mixture.

Table (1) Chemical and physical traits of the soil used in the experiment.

values	units	traits
7.5		pH
2.43	$ds.m^{-1}$	ECe
Sandy loam	Sandy loam	Texture
72.19	mg L^{1-}	Sand
3513.	mg L^{1-}	silt
14.46	mg L^{1-}	Clay
23.65	mg L^{1-}	N
6.57	mg L^{1-}	P
114.73	mg L^{1-}	K

Study Factors:

The study included a factorial experiment with two factors:

Factor 1: Two Morinka tree cultivars

1- Morinka oleifera

2- Morinka shua

Factor 2: Fertilizer combinations

1- Distilled water (without addition)

2- Nano-NPK fertilizer at a concentration of 1 g/L-1

3- Nano-NPK fertilizer at a concentration of 2 g/L-1

4- Organic fertilizer, concentration 1 (mixing 1 kg of peat moss fertilizer with 3 kg of soil) for each experimental unit

5- Organic fertilizer, concentration 2 (mixing 2 kg of peat moss fertilizer with 3 kg of soil) for each experimental unit.

Nano-NPK fertilizer was applied as a foliar spray until completely wet in the early morning, and the organic fertilizer was mixed with the soil used at the beginning of planting.

Experimental Design

The experiment was designed according to a Randomized Complete Block (R.C.B.D) design as a factorial experiment with two factors. The first factor included the cultivars (Morinca oleifera and Morinca shua) and the second factor included a fertilizer combination (5 levels). The number of experimental units was 2 x 5 x 3, equaling 30 experimental units, with 3 plants per experimental unit, resulting in a total of 90 plants. The following traits were measured:

3-4 Traits Studied

1- Plant Height (cm)

Plant height was measured using a measuring tape in each experimental unit for each replicate, from the soil surface to the top of the plant, and the average plant height was calculated.

2- Stem Diameter (cm)

The diameter of the primary stem was measured in an experimental unit 10 cm from the soil surface in the Salamiyah area using a digital vernier caliper, and the average was recorded.

3- Number of leaves (leaf per plant)

The number of leaves was counted for each treatment for each replicate, and the average number of leaves per plant was calculated.

4- Lateral branches (leaf per plant)

The number of lateral branches on the main stem of each plant was calculated for each experimental unit.

5- Leaf area (cm2/plant)

Five fully developed and expanded leaves were photographed using a Sannar scanner for each experimental unit. The area of each leaf was then calculated using the Digitizer program. The leaf area was then multiplied by the number of leaves per plant, and the total leaf area of the plant was calculated (Carvalho et al., 2017).

6- Dry matter of the vegetative system (g/plant)

Three leaves were taken from each plant in the experimental unit and placed in paper bags. After recording their fresh weight, they were placed in an electric oven at 72°C for 48 hours until the weight stabilized. They were weighed using a sensitive balance, and then recorded and calculated as the dry weight of the vegetative system.

RESULTS AND DISCUSSION

Results:

1- Plant Height (cm)

The results of the statistical analysis (Table (2)) show that the study factors had a significant effect on plant height. The results showed that the Oleifera cultivar excelled the Oleifera cultivar, achieving the highest height of 165.18 cm, compared to the Shua cultivar, which achieved the lowest height of 47.91 cm. The fertilizer combination levels were superior, with the concentration (2 g L-1 nano-NPK) achieving the highest height of 130.56 cm, compared to the control treatment, which achieved the lowest height of 91.32 cm. Regarding the two-way interaction between the two cultivars and the fertilizer combination, the combination (Oleifera + 2 g L-1 nano-NPK) excelled, achieving the highest average height of 195.50 cm. Meanwhile, the combination (Shua + control treatment) achieved the lowest height of 37.33 cm.

Table (2) The effect of fertilizer combinations on the plant height (cm) of two Moringa tree cultivars.

average cultivars	fertilizer combinations					cultivars
	2 kg Organic	1 kg Organic	2 g.L-1 NPK	1 g.L-1 NPK	0	
165.18	163.06	157.44	195.50	164.61	145.30	Oliveira
47.91	50.89	41.17	65.61	44.56	37.33	Shua
	106.97	99.31	130.56	104.58	91.32	Average fertilizer combinations
LSD 0.05						
interaction	combinations					cultivars
1.188	2.656					1.878

2- Number of leaves (leaf per plant)

The results of the statistical analysis (Table (3)) show that the study factors had a significant impact on the number of leaves trait, as the results showed that the Shua cultivar was excelled, giving the highest number of leaves, 19.11 leaves per plant, while the Olivera cultivar gave the lowest number, 16.75

leaves per plant. As for the levels of the fertilizer combination, the concentration (2 g L-1 - NPK nano) was excelled, giving the highest number of leaves, reaching 24.67 leaves per plant, compared to the control treatment, which gave the lowest number of leaves, 11.17 leaves per plant. As for the two-way interaction between the two cultivars and the fertilizer combination, the combination (Shua + 2 g L-1 - NPK nano) was excelled, giving the highest number of leaves, 27.00 leaves per plant, while the combination (Olivera + control treatment) gave the lowest number of leaves, reaching 10.33 leaves . plant. $^{-1}$.

Table (3) Effect of fertilizer combinations on the number of leaves (leaf per plant) for two Moringa tree cultivars.

average cultivars	fertilizer combinations					cultivars
	2 kg Organic	1 kg Organic	2 g.L-1 NPK	1 g.L-1 NPK	0	
16.75	17.22	14.33	22.33	19.55	10.33	Oliveira
19.11	23.11	15.44	27.00	18.00	12.00	Shua
	20.17	14.89	24.67	18.78	11.17	Average fertilizer combinations
LSD 0.05						
interaction	combinations					cultivars
0.707	1.582					1.119

3- Stem Diameter (cm)

The results of the statistical analysis (Table (4)) show that the study factors had a significant impact on stem diameter. The results showed that the Olivera cultivar excelled, yielding the stem diameter of 2.7100 cm, while the Shua cultivar yielded the lowest average stem diameter of 0.6953 cm. The fertilizer combination levels were superior, with the concentration (2 g L-1 - nano-NPK) yielding the stem diameter average of 2.2200 cm, compared to the control treatment, which yielded the lowest average of 1.3850 cm. As for the two-way interaction between the two cultivars and the fertilizer combination, the combination (Olivera + 2 g L-1 - nano-NPK) yielded the stem diameter average of 3.5567 cm, while the combination (Shua + control treatment) yielded the lowest average of 0.5533 cm.

Table (4) Effect of fertilizer combinations on the stem diameter (cm) of two Moringa tree cultivars

average cultivars	fertilizer combinations					cultivars
	2 kg Organic	1 kg Organic	2 g.L-1 NPK	1 g.L-1 NPK	0	
2.7100	2.7267	2.4367	3.5567	2.6133	2.2167	Oliveira
0.6953	0.7133	0.6200	0.8833	0.7067	0.5533	Shua
	1.7200	1.5283	2.2200	1.6600	1.3850	Average fertilizer combinations
LSD 0.05						

interaction	combinations	cultivars
0.01497	0.03347	0.02367

4- Number of lateral branches (plant branch) 1-

The results of the statistical analysis (Table (5)) show that the study factors had a significant impact on the number of lateral branches. The results showed that the Shua cultivar excelled, giving it the highest number of branches (4.04 plant branches), while the Oleifera cultivar gave it the lowest number of branches (1.53 plant branches). As for the levels of the fertilizer combination, the concentration (2 g L-1 - NPK nano) was excelled, giving it the highest number of branches (4.11 plant branches), compared to the control treatment, which gave it the lowest number of branches (1.89 plant branches). As for the two-way interaction between the two cultivars and the fertilizer combination, the combination (Shua + 2 g L-1 - NPK nano) was excelled, giving it the highest number of branches (6.44 plant branches), while the combination (Oleifera + control treatment) gave it the lowest number of branches (1.33 plant branches).

Table (5) The effect of fertilizer combinations on the number of lateral branches (plant branch) of two Moringa tree cultivars.

average cultivars	fertilizer combinations					cultivars
	2 kg Organic	1 kg Organic	2 g.L-1 NPK	1 g.L-1 NPK	0	
1.53	1.44	1,67	1.78	1.44	1.33	Oliveira
4.04	4.11	2.78	6.44	4,44	2.44	Shua
	2.78	2.22	4.11	2.94	1.89	Average fertilizer combinations
LSD 0.05						
interaction	combinations					cultivars
0.461	1.031					0.729

5- Leaf area (cm2 plant-1)

The results of the statistical analysis (Table (6)) show that the study factors had a significant impact on the leaf area trait. The results showed that the Oleifera cultivar excelled it by giving it the largest leaf area of 2238.69 cm2 plant-1, while the Shua cultivar gave the least leaf area of 1536.71 cm2 plant-1. As for the levels of the fertilizer combination, the concentration (2 g L-1 - NPK nano) was excelled, giving it the highest leaf area of 2503.72 cm2 plant-1 compared to the control treatment, which gave the lowest leaf area of 1646.79 cm2 plant-1. As for the two-way interaction between the two cultivars and the fertilizer combination, the combination (Oleifera + 2 g L-1 - NPK nano) excelled it by giving it the highest leaf area of 3250.33 cm2 plant-1, while the combination (Shua + control treatment) gave the least leaf area. 1421.67 cm2 plant-1.

Table (6) Effect of fertilizer combinations on leaf area (cm2 plant-1) for two Moringa tree cultivars

average cultivars	fertilizer combinations					cultivars
	2 kg Organic	1 kg Organic	2 g.L-1 NPK	1 g.L-1 NPK	0	
2238.69	2106.66	1948.67	3250.33	2015.89	1871.92	Oliveira
1536.71	1530.00	1447.66	1757.11	1527.11	1421.67	Shua
	1818.33	1698.17	2503.72	1771.50	1646.79	Average fertilizer combinations
LSD 0.05						
interaction	combinations					cultivars
3.268	7.307					5.167

6- DRY MATTER CONTENT OF THE VEGETATIVE PART (G PLANT-1)

The results of the statistical analysis (Table (7)) show that the study factors had a significant impact on the dry matter content of the vegetative part. The results showed that the Oleifera cultivar was excelled, giving the highest dry matter content of 19.379 g plant-1, while the Shua cultivar gave the lowest dry matter content of 13.357 g plant-1. As for the levels of the fertilizer combination, the concentration (2 g L-1 - NPK nano)) was excelled, giving the highest dry matter content of 19.312 g plant-1 compared to the control treatment, which gave the lowest dry matter content of 13.325 g plant-1. As for the two-way interaction between the two cultivars and the fertilizer combination, the combination (Oleifera + 2 g L-1 - NPK nano) was excelled, giving the highest dry matter content of 22.950 g plant-1, while the combination gave (Shua + control treatment) The lowest dry matter content was 10.437 g plant-1.

Table (7) Effect of fertilizer combinations on the dry matter content of the vegetative part (g plant-1) for two Moringa tree cultivars.

average cultivars	fertilizer combinations					cultivars
	2 kg Organic	1 kg Organic	2 g.L-1 NPK	1 g.L-1 NPK	0	
19.379	19.613	18.143	22.950	19.973	16.213	Oliveira
13.357	14.213	13.060	15.673	13.400	10.437	Shua
	16.913	15.602	19.312	16,687	13.325	Average fertilizer combinations
LSD 0.05						
interaction	combinations					cultivars
0.1431	0.3199					0.2262

DISCUSSION:

The results of the statistical analysis (Tables 1, 3, 5, and 6) showed that the Olivera cultivar excelled the majority of the studied traits, yielding the highest average height, stem diameter, leaf area, and dry matter compared to the Sho'a cultivar. The Sho'a cultivar also excelled the number of leaves. Lateral branches. Tables (2-4) show the results of the statistical analysis. The highest average number of leaves was obtained. The number of lateral branches may be due to the genetic makeup of the two cultivars. As for the fertilizer combinations, Tables (6-5-4-3-2-1) show that the statistical analysis results showed that the concentration of 2 mg L-1 nano-NPK was excelled in the traits under study (plant height, number of leaves, stem diameter, lateral branches, leaf area, dry matter). The rates of the traits increased directly with the increase in the concentration of nano-NPK fertilizer, as the concentration of 2 mg L-1 gave the highest rates. This explains that nano-NPK fertilizer increases the plant's efficiency in absorbing water and nutrients, and that nutrients and macronutrients play an effective role in various metabolic processes in the plant, thus increasing growth, which is positively reflected in the activity of the vegetative system. This leads to an increase in the traits of the vegetative system as a result of cell expansion due to growth hormones. This leads to an increase in the number of branches and their length, and consequently an increase in the number of leaves and an increase in the height of the plant. Leaf area, which in turn is reflected in other results, is consistent with what Buzee et al. (2007). This result is consistent with what Ihsan (1999) reached when fertilizing mint (Mentha spicata) and squid (Mentha longifolia), who observed that nitrogen fertilization led to an increase in plant height compared to unfertilized plants. The presence of abundant nitrogen in NPK fertilizer also led to an increase in cell division and elongation. These results are consistent with what Foidl et al. (2001) and Nouman et al. (2012). The presence of nitrogen fertilizer in NPK fertilizer stimulates cell elongation. These results are consistent with what Moyo et al. (2011) and Anyagbu et al. (2013).

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