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EFFECT OF ROOT TREATMENT WITH MYCORRHIZA AND FOLIAR APPLICATION WITH MORINGA LEAF EXTRACT ON NPK ELEMENTS IN CITRULLUS COLOCYNTHIS LEAVES

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Abstract

A field experiment conducted at the 2021 agricultural season in one of the agricultural field in Anbar Governorate - Fallujah district to study the effect of root treatment with different concentrations of Mycorrhizal fungi and folair application with different concentrations of Moringa leaf extract and the interaction between them on the proportion of mineral elements in *Citrullus Colocynthis* leaves. The experiment carried out in a randomized complete block design (R.C.B.D) with three replications. The experiment included 16 treatments, inoculation with four concentrations of mycorrhizal fungi (0, 15, 20, 25 g), folair application with four concentrations of moringa leaf extract (0, 100, 200, 300 g. L^{-1}) and the interaction treatment between them. The averages compared using the least significant difference L.S.D at a probability level of 0.05. The results showed that the inoculation of roots with mycorrhizal fungi gave significant differences in the studied traits, as the inoculation with mycorrhizal fungi at concentration 25 g for each plant achieved the highest values for some of the studied traits, which significantly outperformed the control treatment without addition in the ratio of nitrogen, phosphorous and potassium. While folair application with Moringa leaf extract when treated 200 g. L^{-1} gave the best results for the ratio of nitrogen, phosphorous and potassium. Whereas, the interaction treatment 25 gm +200 gm/l between the mycorrhizal inoculum and moringa leaf extract, respectively, gave the highest percentage of nitrogen in the leaves, while the interaction

treatment 20 gm +200 g. L^{-1} between the mycorrhizal inoculum and moringa leaf extract, respectively, achieved the highest rate of phosphorous. and potassium in the leaves.

Keywords: Mycorrhiza, Moringa, Folair application, NPK, Citrullus Colocynthis.

تأثير معاملة الجذور بالمايكورايزا والرش الورقي بمستخلص اوراق نبات المورينجا في نسبة عناصر NPK في اوراق نبات الحنظل Citrullus Colocynthis

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الخلاصة

تم اجراء تجربة حقلية للموسم الزراعي 2021 في أحد الحقول الزراعية في محافظة الانبار – قضاء الفلوجة لدراسة تأثير معاملة الجذور بتراكيز مختلفة من فطريات المايكورايزا والرش الورقي بتراكيز مختلفة من مستخلص أوراق نبات المورينجا والتداخل بينهما في نسبة العناصر المعدنية في اوراق نبات الحنظل *Citrullus Colocynthis*. نفذت التجربة بتصميم القطاعات العشوائية الكاملة R.C.B.D وبثلاث مكررات تضمنت التجربة 16 معاملة ناتجة عن معاملة المقارنة ومعاملة التلقيح بأربع تراكيز من فطريات المايكورايزا (0، 15، 20 و25 غم/ نبات) ومعاملة الرش الورقي بأربع تراكيز من مستخلص اوراق نبات المورينجا (0، 100، 200 و300 ملغم/ لتر) ومعاملة التداخل بينهما وقورنت المتوسطات باستعمال اقل فرق معنوي L.S.D عند مستوى احتمالية 0.05. بينت النتائج ان تلقيح الجذور بفطريات المايكورايزا اعطى فروقا معنوية في الصفات المدروسة، اذ حققت معاملة التلقيح بفطريات المايكورايزا عند التركيز 25 غم لكل نبات اعلى قيم لبعض الصفات المدروسة والتي تفوقت معنويا على معاملة المقارنة بدون اضافة في كل من نسبة النتروجين والفسفور والبوتاسيوم. بينما اعطى الرش الورقي بمستخلص اوراق نبات المورينجا عند المعاملة 200 غم/لتر أفضل النتائج لنسبة النتروجين والفسفور والبوتاسيوم. في حين اعطت معاملة التداخل 25 غم +200 غم/لتر بين لقاح المايكورايزا ومستخلص اوراق المورينجا على التوالي اعلى نسبة للنتروجين في الاوراق، بينما حققت معاملة التداخل 20 غم +200غم/لتر بين لقاح المايكورايزا ومستخلص اوراق المورينجا على التوالي اعلى معدل لنسبة الفسفور والبوتاسيوم في الاوراق.

كلمات مفتاحية: مايكورايزا، مورينجا، الإضافة الورقية، NPK، الحنظل.

Introduction

Medicinal plants at the present time received wide attention in research centers because of their great importance, especially in the safety of societies, and mainly the therapeutic properties of medicinal plants because they contain a large group of chemicals with a distinctive composition (18). Bitter melon (*Citrullus Colocynthis*) considered one of the important medicinal plants belonging to the family of Cucurbitaceae, and it is one of the well-known plants in traditional medicine. Bitter melon grows in the hot and warm desert regions of the continents of Asia and Africa. It is also spread in the Arab region such as Morocco, Egypt and Sudan (3). Its fruits contain different substances, especially resins, alkali, pectin, and Saponines. They also contain Colocynth, which is a very bitter substance, and Colocynth was found to be a mixture of alkali materials and a glycoside (2). Found (19) that the fruits of bitter melon contain resinous substances Resins, alkaloids, Saponines, carbohydrates, flavonoids and amino acids. It also contains oil at a rate of 15-17% in addition to the active drug compound Colocynthine and Colocynthitine.

Moringa oleifera a tree belongs to the family Moringaceae and is a perennial plant (12), and it is a plant that tolerates both severe drought or moderate frost and therefore can be widely cultivated all over the world (8 and 10), indicated that the original habitat was in the Indian subcontinent and spread in the tropical and subtropical regions. *Moringa oleifera* is a fast-growing tree that can reach a height of 7-12 m, and its stem diameter ranges from 20-60 cm. The trunk is usually straight. The tree grows with a straight stem that reaches a height of 1.5-2 m before it begins to branch and may reach 3 meters (6), as (14) indicated that the dry leaves of the plant contain 12 times more vitamin C than oranges and 10 times vitamin A from carrots, 17 times the calcium from milk, 15 times the potassium from bananas, 25 times the iron from spinach, and 9 times the proteins from yogurt. (15) explained that phytochemicals such as flavonoids, Saponines, alkaloids, etc. responsible for the medicinal value of the moringa plant. For worms and others, the Moringa plant in India used to treat common diseases due to its availability and ease of preparation because it has nutritional, medical, pharmaceutical and industrial values.

Mycorrhiza a group of soil fungi called Arbuscular mycorrihza fungi (AMF), which form a symbiotic relationship with plants, as this symbiotic relationship helps the plant to obtain phosphorous and protect it from biotic and abiotic stresses. It known to promote plant growth by dissolving phosphate and producing hormones vegetable. Which has a symbiotic relationship with the roots of many vascular plants under natural conditions, and it is an unsatisfactory symbiotic relationship to which the host plant responds, improving its growth and physiological characteristics, and increasing its resistance to diseases and many environmental stresses such as drought, freezing and salinity. (7) also indicated that shrub mycorrhiza belongs to the class of Glomermycetes, which infect the roots of many plants and have a symbiotic relationship with them, which is one of the beneficial non-pathological relationships that arise between a certain group of fungi and the roots of many vascular plants of

different types and degrees Promote it for its important role in plant nutrition and growth through continuous supply of most of the macro and micro nutrients for plants.

Materials and Methods

A field experiment conducted for the cultivation of bitter melon in one of the agricultural fields in the city of Fallujah - Anbar Governorate. The soil analyzed before the experiment carried out by taking random samples from different sites of field soil with a depth ranging between 0-30 cm. The samples mixed well to be a representative model of the field soil and then the samples were analyzed in the central laboratory of the College of Agriculture, University of Anbar to identify the physical and chemical properties of the soil as shown in table 1.

Table 1 shows the physical and chemical properties of soil.

Adjectives	Values	Unit of Measure
EC	1.84	ds. m^{1}
PH	7.31	
N	33	mg kg^{-1} soil
P	5.13	mg kg^{-1} soil
K	75	mg kg^{-1} soil
Mud	170	g. kg^{-1}soil
Silt	360	
Sand	470	
Soil texture	Mix	

The treatments distributed according to the Randomized Complete Block Design (R.C.B.D) with two factors and three concentrations for each factor in addition to the interactions between the two factors and three replications for each treatment. Bitter melon seeds obtained from the Desert Studies Center / University of Anbar, and the Mycorrhizal inoculum (roots of plants infected with Mycorrhizal fungi, Mycorrhizal spores and soil in the form of a homogeneous mixture) obtained from the College of Agriculture /University of Anbar. The inoculum examined by wet sieving to ascertain the density of Mycorrhizal spores belonging to the genus Glomus sp, according to the method of (9). Moringa leaves were obtained from adult trees. The mature leaves picked, then washed and cleaned well of dust and impurities, and after drying, they were left to air dry in the normal air without exposing them to sunlight. After the leaves were completely dry, they crushed using an electric grinder and keeping the powder of the leaves in sterile bottles for use in the preparation of Moringa leaf extract for the purpose of folair application.

The field land plowed by two orthogonal plows well before planting and left for 5 days for the purpose of ventilation. Then the land was softened to get rid of clumps and remove impurities from it. Then the land was divided into 8 stalks and shoulders for the purpose of cultivation and irrigation. The length of 4 meters and the distance between them is 2 meters. A hole was dug at a depth of 5 cm and the distance between one hole and another was 40-50 cm. The mycorrhizal inoculum was added in

four concentrations :0, 15,20,25 g (each gram of the inoculum contains 50 spores) to each hole before planting the seeds. Then the seeds were planted by three seeds for each hole, after which irrigation was carried out until saturation and the seeds were left in order to sprout. Germination was done and the first sprouts appeared after 5-8 days. After the germination and the emergence of vegetative buds, that was, after 14 days of planting, the plants thinned to one plant per hollow.

The treatment was carried out with the second factor, which was spraying with the extract of moringa leaves after 21 days of planting when the number of leaves became from 3 to 5 leaves, and the spraying process was carried out with four concentrations also 0,100, 200, 300 g. L^{-1} spraying on the leaves until complete wetness after 48 hours of Watering plants. Then the plants were left to grow until the second treatment, two weeks after the first treatment, used foliar spray until completely wet. The spraying process carried out using a manual sprayer with a capacity of 2 liters, and the spraying process carried out in the early morning, since the plant was at the beginning of its activity and to avoid high temperature. Raise the ability of the plant to take advantage of the solution. The data for the studied traits had taken after 90 days of planting the plant and included the following:

1. Determination of the percentage of nitrogen, N% the which estimated using the Macro Kieldahl device, according to (5).
2. Determination of the percentage of phosphorous (P%) which was estimated using ammonium molybdate and ascorbic acid using a spectrophotometer at a wavelength of 882 nm according to (16)
3. Determination of the percentage of potassium K% which was estimated by Flam photometer according to (17).

Results and Discussion

The results in table 2 showed a significant different between the treatments of inoculation with Mycorrhiza and folair application with moringa leaf extract and the interactions between them. The treatment with Mycorrhiza (25 g/plant) was superior, which gave the highest nitrogen rate in leaves of 3.152% compared to the control treatment without addition, which gave an average of 2.962% of nitrogen in the leaves. While the foliar spray treatment with moringa leaf extract (200 g. L^{-1}) achieved the highest nitrogen rate in the leaves, which was 3.189% compared to the control treatment without addition, which gave the lowest nitrogen rate in the leaves amounted to 2.852%. From the same table, the interaction treatment was recorded (25 g + 200 g / Liter) between Mycorrhiza inoculum and Moringa leaf extract had the highest rate of nitrogen in leaves that reached 3.288%, while the control treatment without adding the lowest rate of nitrogen in leaves was 2.536%.

Table 2 The effect of mycorrhizal inoculum and moringa leaf extract and the interaction between them in leaf nitrogen (%).

Moringa leaf Extract (g/l) / Mycorrhiza (g)	0	100	200	300	MEAN(%)
0	2.536	2.992	3.220	3.102	2.962
15	2.656	2.764	2.988	2.820	2.807
20	3.080	3.036	3.260	3.094	3.117
25	3.136	3.064	3.288	3.120	3.152
MEAN(%)	2.852	2.964	3.189	3.034	3.010
LSD 5%	Mycorrhiza		Moringa	Mycorrhiza + Moringa	
	0.0716		0.0716	0.1433	

The percentage of phosphorous in the leaves: The results in table 3 indicated a positive effect in increased the percentage of phosphorous in the leaves as a result of inoculation with Mycorrhizal fungi and folair application with Moringa leaf extract and the interactions between them, as the inoculation with Mycorrhizal fungi (25 g/plant) gave the highest rate of phosphorus in the leaves It amounted to 0.14000 %, while the control treatment without adding the lowest rate of phosphorus in the leaves amounted to 0.007750%. Also, the folair application treatment with Moringa leaf extract (200 g. L^{-1}) achieved the highest rate of phosphorous in the leaves amounted to 0.014250% compared with the control treatment that gave the lowest The average percentage of phosphorous in the leaves was 0.009500%, while the interaction treatment (20 gm + 200gm/ L) between Mycorrhiza and Moringa, respectively, had the highest rate of phosphorous in leaves that amounted to 0.019000%, while the control treatment without adding the lowest rate of phosphorous in leaves was 0.005000% .

Table 3 Effect of mycorrhizal inoculum and Moringa leaf extract and the interaction between them on the percentage of phosphorous in leaves (%).

Moringa leaf extract (g/l) / Mycorrhiza (g)	0	100	200	300	MEAN(%)
0	0.005000	0.006000	0.009000	0.011000	0.007750
15	0.008000	0.009000	0.012000	0.013000	0.010500
20	0.011000	0.012000	0.019000	0.013000	0.013750
25	0.014000	0.011000	0.017000	0.014000	0.014000
MEAN(%)	0.009500	0.009500	0.014250	0.012750	0.011500
LSD 5%	Mycorrhiza		Moringa	Mycorrhiza + Moringa	
	0.0004962		0.0004962	0.0009924	

Percentage of potassium in the leaves: It was noted from the results of table 4 recorded significant differences between the inoculation with Mycorrhizal fungi and the foliar spray with Moringa leaf extract and the interactions between them. The control without adding an average percentage of potassium in the leaves amounted to

1.0710%, while the folair application treatment with Moringa leaf extract 200 g. L^{-1} achieved the highest percentage of potassium in the leaves amounted to 1.2043% compared to the control treatment without addition that achieved the lowest rate of potassium in the leaves amounted to 0.7197% Whereas, the interaction treatment 20 g + 200 g /L between Mycorrhiza and Moringa, respectively, achieved the highest rate of potassium in the leaves, which amounted to 1.2700%, compared to the comparison treatment without addition, which gave the lowest rate of potassium in the leaves was 0.5440%.

Table 4 Effect of Mycorrhiza vaccine and Moringa leaf extract and the interaction between them in Potassium content in leaves (%).

Moringa leaf extract (g/l) / Mycorrhiza (g)	0	100	200	300	MEAN(%)
0	0.5440	1.2100	1.3800	1.1500	1.0710
15	0.5520	0.8800	0.9850	0.8520	0.8173
20	0.7990	1.0040	1.2700	1.0970	1.0425
25	0.9840	1.0270	1.1820	1.0897	1.0707
MEAN(%)	0.7197	1.0302	1.2043	1.0472	1.0004
LSD 5%	**Mycorrhiza**		**Moringa**	**Mycorrhiza + Moringa**	
	0.01459		**0.01459**	**0.02917**	

The reason for the high ratios of nitrogen, phosphorous and potassium elements in the leaves (Tables 1, 2, 3) may be due to the positive role played by the mycorrhizal fungi through the symbiotic relationship with the roots of the host plant, as the early infection of the roots with the mycorrhizal fungi encourages the formation of many root hairs from during the spread of fungal hyphae and their access to long distances in the soil, thus increasing the ability to absorb the largest amount of mineral nutrients from areas and long distances, the most important of which are nitrogen, phosphorous and potassium , and their delivery to plant tissues (11 and 13).

The increased in the mineral elements may be attributed to the effect of the extract of the moringa leaves, as it contain an abundance of nutrients and vitamins, and therefore the foliar spray allows to provide the leaves with the necessary nutrients directly and thus obtain the optimal mineral nutrition for the plants, and this was confirmed by (1) where he confirmed that the moringa plant leaves contain high concentrations of compounds and nutritional components, as they contain proteins, antioxidant compounds, vitamins B1, B2, B3 and also contain nutrients such as calcium, potassium, phosphorous, iron, copper, sulfur, magnesium, sodium and zinc, as indicated by (4).

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