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EFFECT OF RUBBER CRUMBS OF USED TIRES AND IRRIGATION WITH SEWAGE WATER ON THE GROWTH OF MORINGA (*MORINGA OLEIFERA* L) IN DESERT SOIL AND ITS CONTENT OF SOME ELEMENTS

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ABSTRACT : A pots experiment was conducted during 2020 at the College of Agriculture, the University of Anbar, to study the effect of used rubber crumbs and irrigation with sewage water on the growth of Moringa and its content of some elements. The experiment included a study of two factors: the first factor was waste tire crumbs at five levels (0, 5, 10, 15 and 20%) based on soil weight which symbol CR0, CR1, CR2, CR3 and CR4 respectively, while the second factor was irrigation (irrigation with common water, alternately irrigation with common and sewage water and irrigation with sewage water) which symbol by W0, W1and W2, respectively. Randomized completely block design (RCBD) according to the factorial arrangement at three replicates was used. The results showed that increasing the levels of adding rubber crumbs led to an increase in vegetative and root dry weight, as well as an increase in the concentration of N, P, K iron, zinc, manganese, cadmium and lead in vegetative growth. Also, the vegetative and root dry weight increased when irrigation with wastewater, in addition to an increase in the concentration of N, P, K, iron, zinc, manganese, cadmium and lead when irrigation with wastewater.

Key words : Used tires, rubber crumbs, wastewater, *Moringaoleifera* L., micronutrients, heavy metals.

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INTRODUCTION

Tens of millions of used tires are thrown around the world every year, and getting rid of waste tires is a difficult process because the lifespan of their decomposition is long, the tire rubber needs 1000 years to decompose. The traditional method of managing waste tires is storing them, dumping them, or illegally burying them. However, all of these methods are short-lived, as stored tires provide an ideal environment for the growth and reproduction of mosquitoes, insects, and snakes. In 1990, more than 240 million used tires were buried in the United States (Alfayez *et al*, 2020). In Iraq, it is estimated that two million tires are thrown into the environment in a year. Therefore, it is necessary to conduct researches that treat the problem of the increasing amounts of used tires (Jumaa, 2011). Sewage water contains solid materials (organic and mineral), pathogens (viruses, parasites, and bacteria), and high concentrations of heavy elements. The sewage water contains 99% water and 1% solid matter, which contain 70% organic matter and 30% inorganic matter and heavy elements. Wastewater is a source of organic matter and some nutrients for plants and improves the physical and chemical properties of soil (Alkatrani and Yesser, 2017) reported that the main pollutants in sewage water are heavy metals, chemicals, and hydrocarbons, in addition to nitrogen and phosphorous, which are considered nutrients within normal limits, and that sewage water contains high concentrations of heavy metals such as zinc, copper, cadmium, lead, nickel, chromium and that it is necessary to reduce these elements by treating them before throwing them into rivers or using them in agricultural purposes (Hassan and Muthen, 2018). Moringa tree (*Moringa oleifera* L.) is one of 13 species belonging to the moringa genus, which belongs to the Moringaceae family and its spread in Africa, South America, and Sudan (Padayachee and Baijnath, 2012). Moringa has many medical benefits; their leaves are a good source of antioxidants and a cancer treatment. Also, It is considered a treatment for asthma, bronchitis, eye, and skin diseases because it contains flavonoids and high levels of vitamins A, B, and C as well as vitamin B (Ahmed *et al*, 2016). Moringa leaves contain high levels of carbohydrates, proteins, and minerals such as magnesium, potassium, iron, zinc and phosphorous and they can be used as a treatment for malnutrition diseases, especially in infants and pregnant women (Nalamwar *et al*, 2017). The desert lands occupy an area of more than 850 thousand Km^2 of the world and constitute an area of about 88 thousand Km^2 in Iraq. Desert soils are common in dry areas and contain high concentrations of calcium, but they are suffering from many problems that limit their exploitation for agricultural purposes, including the chemical and physical properties of the soil (Al-Hadithy *et al*, 2008).

Therefore, this research was conducted to study the effect of rubber crumbs of used tires and irrigation with sewage water on the growth of Moringa in desert soil and its leaves content of some macronutrients and heavy elements.

MATERIALS AND METHODS

A pots experiment was conducted during 2020 at the College of Agriculture, the University of Anbar, to study the effect of using rubber crumbs and irrigation with sewage water on the growth of Moringa (*Moringa oleifera* L.) and its content of some elements. The experiment included a study of two factors: the first factor was waste tire crumbs at five levels (0, 5, 10, 15, and 20%) based on soil weight which symbol CR0, CR1, CR2, CR3 and CR4 respectively, while the second factor was irrigation (irrigation with common water, alternately irrigation with common and sewage water and irrigation with sewage water), which symbol by W0, W1 and W2, respectively. Randomized completely block design (RCBD) according to the factorial arrangement at three replicates was used. Plastic pots with a capacity of 15 Kg were used, the upper diameter was 0.26 m, the lower was 0.17 m, and the height was 0.30 m. A filter paper was placed under each pot and a layer of fine gravel at a thickness of 0.05 m was placed, then the soil was homogeneously mixed with rubber crumbs according to the treatments. Some chemical Properties of soil were carried out (Table 1). The pots were irrigated with wastewater and common water according to the treatments. The chemical properties of wastewater are shown in Table 2. The seeds of Moringa were sown on 1 Nov. 2020. Nitrogen fertilizer was added at a level of 50 Kg N as urea at three doses, the first dose at planting, the second after a month of the first, and the third after a month of the second dose, whereas the phosphate fertilizer was added at a level of 30 Kg P as triple superphosphate fertilizer with one dose with planting. After 8 mounts plants were harvested. Dry weight of vegetative and root were measured. The concentrations of N, P, K, Fe, Zn, Mn, Cd and Pb in the leaves of plants were measured (Page, 1982 and Richards, 1954).

Table 1 : Some chemical properties of the studied soil.

Adjective		Unit	The value
pH			8.28
EC		dS m^{-1}	2.84
Organic matterr		g Kg^{-1}	0.30
$CaSO_4$ $2H_2O$		g Kg^{-1}	59.90
$CaCO_3$		g Kg^{-1}	280.06
CEC		Cmol Kg^{-1}	11.66
Solube Cation	Ca^{2+}	mmol l^{-1}	17.5
	Mg^{2+}		24.7
	Na^+		7.22
	K^+		3.25
Soluble Anion	Cl^-	mmol l^{-1}	19.01
	SO_4^{-2}		14.30
	HCO^{-3}		2.3

Table 2 : Some chemical properties of wastewater.

Adjective	Unit	The value
pH		7.55
EC	dS m^{-1}	1.78
Ca	mmol l^{-1}	3.03
Mg	mmol l^{-1}	2.47
Na	mmol l^{-1}	5.96
K	mmol l^{-1}	0.61
Cl	mmol l^{-1}	5.12
HCO_3	mmol l^{-1}	1.96
SO_4	mmol l^{-1}	1.66
Fe	mg Kg^{-1}	2.11
Mn	mg Kg^{-1}	2.15
Zn	mg Kg^{-1}	0.68
Cu	mg Kg^{-1}	0.32
Cd	mg Kg^{-1}	0.23
Pb	mg Kg^{-1}	0.49

RESULTS AND DISCUSSION

Effect of adding rubber crumbs and irrigation with sewage water on Moringa growth, (dry weight of vegetative and roots) and its content of some macronutrients

The results in Table 3 shows a significant increase in the plant dry weight with an increase in the levels of rubber crumbs. The adding of rubber crumbs at 20% (CR4) gave the highest mean (5.98 g pot^{-1}) at an increasing 11.2% compared with no rubber crumbs were added (CR0), which gave the lowest (5.38 g pot^{-1}). Also, the irrigation with sewage water (W2) was significantly superior and achieved the highest mean of plant dry weight (5.99 g pot^{-1}) compared with alternating irrigation (W1)

Table 3 : Effect of level of rubber crumbs and irrigation with wastewater on the growth of moringa and its content of nutrients.

CR	W	Vegetative Dry Weight (g)	Root dry Weight (g)	N g Kg -1	P g Kg -1	K g Kg -1
CR0	W0	5.04	2.13	39.10	19.27	12.39
	W1	5.42	2.22	39.83	19.40	12.68
	W2	5.68	2.31	39.26	20.02	12.73
	MEAN CR0	5.38	2.22	39.3	19.56	12.6
CR1	W0	5.55	2.20	40.40	20.20	13.30
	W1	5.73	2.22	41.30	20.50	13.60
	W2	5.79	2.23	41.60	20.70	13.80
	MEAN CR1	5.69	2.22	41.1	20.46	13.5
CR2	W0	5.62	2.33	40.30	20.30	13.50
	W1	5.75	2.53	41.60	20.70	13.70
	W2	6.40	2.61	41.70	20.90	13.90
	MEAN CR2	5.80	2.49	41.2	20.63	13.7
CR3	W0	5.67	2.42	40.50	20.50	13.60
	W1	5.83	2.52	41.70	20.70	13.90
	W2	6.14	3.31	41.90	21.20	14.10
	MEAN CR3	5.88	2.75	41.3	20.8	13.8
CR4	W0	5.72	2.51	40.60	20.70	13.70
	W1	5.93	2.71	41.80	20.90	13.80
	W2	6.29	3.39	42.10	21.50	14.20
	MEAN CR3	5.98	2.87	41.5	21.03	13.9
MEAN W0		5.52	2.31	40.18	20.19	13.29
MEAN W1		5.73	2.44	41.24	20.44	13.53
MEAN W2		5.99	2.77	41.31	20.86	13.74
$LSD_{0.05}$ CR=		0.11	0.04	0.39	0.28	0.24
W=		0.08	0.03	0.30	0.22	0.19
CR*W=		0.19	0.08	0.69	0.49	0.43

which achieved (5.73 g pot^{-1}) and irrigation with common water (W0), which achieved the lowest (5.52 g pot^{-1}). The reason for an increase in plant dry weight may be attributed to the improvement of the chemical properties of the plant and then the increase in the availability of nutrients (Irhayyim *et al*, 2016). Also, irrigation with sewage water may have improved the plant's up take of macro and micronutrients (Moazzam-Khan *et al*, 2009). The interaction between the quality of irrigation water and the levels of rubber crumbs had a significant effect on the plant dry weight, the adding of rubber crumbs at 20% (CR4) with irrigation with sewage water (W2) recorded the highest value (6.29 g pot^{-1}) whereas no adding rubber crumbs (CR0) with irrigation with common water gave (W0) the lowest value (5.04 g pot^{-1}).

The results in Table 3 reveal a significant increase in the root dry weight with an increase in the levels of rubber crumbs. The adding of rubber crumbs at 20% (CR4) had the highest mean (2.87 g pot^{-1}) at an increasing 29.27% compared with no rubber crumbs were added (CR0) which had a lowest (2.22 g pot^{-1}). Also, the irrigation with sewage water (W2) was significantly superior and gave the highest mean of root dry weight (2.77 g pot^{-1}) compared with alternating irrigation (W1), which gave (2.44 g pot^{-1}) and irrigation with common water (W0) which gave the lowest (2.31 g pot^{-1}). The reason for an increase may be due to the role of sewage water in improving the chemical and physical properties of the soil as a result of its content of organic matter and the necessary macro and micronutrients for the plant, thus supplying the soil with many nutrients and increasing their uptake by the roots of the plant which led to an increase the root dry weight (Alkatrani and Yesser, 2017). These results are in agreement with (Irhayyim *et al*, 2016). The interaction between the quality of irrigation water and the levels of rubber crumbs had a significant effect on the root dry weight, the adding of rubber crumbs at 20% (CR4) with irrigation with sewage water (W2) recorded

Table 4 : Effect of rubber crumbs and irrigation with sewage water in the content of microelements and heavy metals (mg Kg^{-1}).

CR	W	Fe	Zn	Mn	Cd	Pb
CR0	W0	253.53	58.33	33.87	1.34	0.84
	W1	248.20	62.20	33.20	1.55	1.08
	W2	268.63	58.53	35.03	1.06	0.85
	MEAN CR0	256.7	59.68	34.03	1.31	0.92
CR1	W0	272.30	66.10	40.10	1.21	1.75
	W1	273.10	68.40	40.50	2.31	1.78
	W2	275.20	69.30	41.20	2.44	1.89
	MEAN CR1	273.5	67.93	40.6	2.32	1.80
CR2	W0	275.10	68.20	40.30	2.35	1.94
	W1	277.30	70.20	40.70	2.55	1.99
	W2	279.30	72.90	41.80	2.62	2.01
	MEAN CR2	277.2	70.43	40.93	2.50	1.98
CR3	W0	277.30	70.20	41.20	2.41	2.02
	W1	279.60	73.20	41.70	2.62	2.21
	W2	282.30	75.30	42.30	2.85	2.39
	MEAN CR3	279.7	72.9	41.73	2.62	2.20
CR4	W0	278.20	70.90	42.30	2.56	2.35
	W1	280.20	75.80	43.20	2.70	2.45
	W2	285.30	78.20	44.20	2.88	2.62
	MEAN CR4	281.2	74.96	43.23	2.71	2.47
MEAN W0		271.2	66.74	39.55	2.17	1.78
MEAN W1		271.6	69.96	39.86	2.34	1.90
MEAN W2		278.1	70.84	40.90	2.37	1.95
$LSD_{0.05}$						
CR=		5.26	0.85	1.16	0.21	0.13
W=		4.07	0.65	0.89	0.16	0.10
CR*W=		9.11	1.47	2.01	0.37	0.23

the highest value (3.39 g pot^{-1}), whereas no adding rubber crumbs (CR0) with irrigation with common water (W0) recorded the lowest value (2.13g pot^{-1}).

The results in Table 3 indicate a significant increase in the leaves content of nitrogen with an increase in the levels of rubber crumbs. The adding of rubber crumbs at 20% (CR4) gave the highest mean (41.5 g Kg^{-1}) at an increasing 5.59% compared with no rubber crumbs were added (CR0), which gave the lowest (39.3 g pot^{-1}). The reason for an increase in leaves content of nitrogen when adding the rubber crumbs at a high level could be due to an increase in the soil content of organic matter (Taheri *et al*, 2011).

Also, the irrigation with sewage water (W2) was significantly superior and achieved the highest mean of leaves content of nitrogen (41.31 g Kg^{-1}) compared with alternating irrigation (W1), which achieved (41.24 g Kg^{-1}) and irrigation with common water (W0), which achieved the lowest (40.18 g Kg^{-1}). The reason for the increase may be due to the high content of sewage water of nitrogen which led to an increase in the concentration of this element in growth media. These results are in agreement with Galavi *et al* (2009) and Tavassoli *et al* (2010), who obtained a significant increase in plant content of nitrogen when irrigation with the sewage water. The interaction between the quality of irrigation water and the levels of rubber crumbs had a significant effect on the leaves content of nitrogen, the adding of rubber crumbs at a 20% (CR4) with irrigation with sewage water (W2) recorded the highest value (42.10 g Kg^{-1}) whereas no adding rubber crumbs (CR0) with irrigation with common water (W0) recorded the lowest value (39.10 g Kg^{-1}).

The results in Table 3 indicate a significant increase in the leaves content of phosphorous with an increase in the levels of rubber crumbs. The adding of rubber crumbs at 20% (CR4) gave the highest mean (21.03 g Kg^{-1}) at an increasing 7.51% compared with no rubber crumbs were added (CR0), which gave the lowest (19.56 g Kg^{-1}). The reason for an increase of Moringa leaves in the content of phosphorous may be attributed to the increase in organic matter in the soil and then the availability of the necessary elements for plant growth. These results are in agreement with Taheri *et al* (2011), who found that the addition of rubber crumbs led to an increase in phosphorous concentration in a plant. Also, the irrigation with sewage water (W2) was significantly superior and achieved the highest mean of leaves content of phosphorus (20.86 g Kg^{-1}) compared with alternating irrigation (W1) which achieved (20.44 g Kg^{-1}) and irrigation with common water (W0) which achieved the lowest (20.19 g Kg^{-1}). This may be attributed to contain sewage water of ready phosphorous. Also, the organic acids dissolved in the sewage water may reduce the soil pH and increase the available phosphorous for uptake by the plant (Abbood and Naser, 2014). The interaction between the quality of irrigation water and the levels of rubber crumbs had a significant effect on the leaves content of nitrogen, the adding of rubber crumbs at a 20% (CR4) with irrigation with sewage water (W2) recorded the highest value (21.50 g Kg^{-1}), whereas no adding rubber crumbs (CR0) with irrigation with common water (W0) recorded the lowest value (19.27 g Kg^{-1}).

The results in Table 3 shows a significant increase in the leaves content of potassium with an increase in the levels of rubber crumbs. The adding of rubber crumbs at 20% (CR4) gave the highest mean (13.9 g Kg^{-1}) at an increasing 10.31% compared with no rubber crumbs were added (CR0) which gave the lowest (12.6 g Kg^{-1}). These results are in agreement with (Taheri *et al*, 2011), who reported that the adding of rubber crumbs had a significant effect in increasing the content of organic matter and the availability of nutrients to the plant.

Also, the irrigation with sewage water (W2) was significantly superior and achieved the highest mean of leaves content of potassium (13.74 g Kg^{-1}) compared with alternating irrigation (W1) which achieved (13.53 g Kg^{-1}) and irrigation with common water (W0) which achieved the lowest (13.29 g Kg^{-1}). The reason for an increase may be due to the high content of sewage water of potassium, which led to an increase in the concentration of ready potassium for absorption by the plant (Abbood and Naser, 2014). The interaction between the quality of irrigation water and the levels of rubber crumbs had a significant effect on the leaves content of potassium, the adding of rubber crumbs at a 20% (CR4) with irrigation with sewage water (W2) recorded the highest value (14.20g Kg^{-1}), whereas no adding rubber crumbs (CR0) with irrigation with common water (W0) recorded the lowest value (12.39 g Kg^{-1}).

The effect of adding rubber crumbs and irrigation with sewage water on some microelements and some heavy metals contents of Moringa leaves

The results in Table 4 indicate a significant increase in the leaves content of micronutrients and heavy metals (Fe, Zn, Mn, Pb and Cd) with an increase in the levels of rubber crumbs. The adding of rubber crumbs at 20% (CR4) achieved the highest means with values 281.2, 74.96, 43.23, 2.71, and 2.47 respectively compared with no rubber crumbs were added (CR0) which gave the lowest means of these micronutrients and heavy metals with values 256.7, 59.68, 34.03, 1.31 and 0.92, respectively. The levels of adding rubber 5%, 10%, and 15% cause an increase in the concentration of Fe, Zn, Mn, Cd and Pb in the plant leaves with a decreasing increase with the increase in the level of adding, meaning that the increase caused by the highest level of adding of rubber crumbs 20% It differs approximately from the added level of 15% of the crumbs. These results are in agreement with Sadeghizadeh and Jalali (2017), who stated that rubber crumb was effective in increasing the concentrations of microelements extracted with DTPA. The results in a table (Alkatrani and Yesser, 2017) reveal that the irrigation with sewage water (W2) was significantly superior and achieved the highest means of leaves content of micronutrients and heavy metals of Fe, Zn, Mn, Pb and Cd with values 278.1, 70.84, 40.90, 2.37, and 1.95 respectively, compared with alternating irrigation (W1) and irrigation with common water (W0), which achieved the lowest means with values of 271.2, 66.74, 39.55, 2.17 and 1.78, respectively. The reason for the increase may be attributed to the sewage water content of micronutrients and heavy metals. However, the amount of these elements didn't reach the toxic limits in the plant (Al-Hadithy *et al*, 2014 and Corcoran *et al*, 2010). Al-Hadithy *et al* (2011) indicated that the toxicity limits for zinc, copper, cobalt, lead, nickel, cadmium and chromium are 100, 5, 100, 50, 300, and 100 mg Kg^{-1}, respectively.

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