Nat. Volatiles & Essent. Oils, 2022; 9(2): 406-416

Effect Of The Type Of Added Weight And Tire Inflation Pressure On Some Field Performance Indicators For The Tractors At Two Different Types Of Soil Texture

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ABSTRACT

The research included a study of the effect of the type of added weight and tire inflation pressure on (vibration, noise, fuel consumption, and percentage of slip), for two different locations (silty loam, clay). The experiment was based on the Randomized Complete Block Design (RCBD) according to split-split plot design and Duncan's new multiple range test was used to compare the averages at the probability level of (0.05). The results showed that the first location (silty loam) was significantly excelled by recording the lowest value of (vibration and fuel consumption), while the second location (clay) recorded the lowest significant value of the percentage of slip. The tire inflation pressure (80 kPa) was significantly excelled by achieving it the lowest value for (vibration, noise, fuel consumption, and percentage of slip). While the water addition treatment recorded the lowest significant value for (vibration, noise, fuel consumption, and percentage of slip).

Keywords: soil texture, tire inflation pressure, added weights, vibration, noise.

1. INTRODUCTION

Vibration and noise is considered one of the methods of evaluating the performance of agricultural tractor, which tractor drivers are exposed to at high levels because of their negative impact on the driver. The researchers are also working on finding solutions to reduce the levels of vibration and noise, where the researchers confirmed that the type of soil, the speed of the tractor, the size and shape of the tire, the inflation pressure, the weights added to the wheels, the presence of the cabin, the technical condition of the engine, the machine and the type of fuel all affect the levels of vibration and noise resulting from agricultural operations, therefore It is not easy to reduce it (Servadio and Belfiore, 2013; Noronha et al., 2005). Fereydooni et al., (2012) indicated in a study to analyze and measure the vibration of three types of tractors (Universal 650, MF 285, and MF 299) and two types of soil condition, the first was not plowed and the second was plowed, and the test results were to obtain the lowest vibration at the tractors (MF285, MF299, and Univ. 650), respectively, where the plowed soil has excelled on the non-plowed in order to obtain the lowest level of vibration affecting the human body. Baesso et al., (2016) showed when evaluating the comfort level in agricultural tractors, during a study whose aim was to evaluate the levels of vibration and noise emitted by different agricultural tractors and comparing the results with the current standards in Brazil, where the noise levels for all the tractors used in this study were higher than the permissible limit. Butkus and Vasiliauskas, (2016) found that the noise level for manufactured tractors from (1980 to 1990) was (90 dB), while the noise level decreased to (73 dB) for tractors manufactured in (2000) and more, due to the technical development of the cabin of the tractor, where it has a great effect in reducing the noise level. Abdel-Moneim and Abdel-Razzaq, (2006) showed in their study the effect of adding water to the rear tires of the tractor or not, with three plowing depths and using the Turning Disc Plows on the percentage of slip, where the effect of adding weight to the tire was significant on the percentage of slip. When adding water, it was observed that the percentage of slip decreased from (12.37%) to (7.64%), with percentage amounted to (38.23%), The reason is due to the increase in the dynamic Steady-state coefficient of the tire as a result of adding water to it. Shahgholi et al., (2019) conducted a study on the effect of the type of tractor drive system on the anti-slip using the (ANFIS) system. Different front speeds for the tractor (1.26, 3.96, and 6.78 km/h), tire pressures (170, 200, and 230 kPa), and added weights (0, 150, and 300 kg) were selected. Reducing tire inflation pressure and adding weights led to reducing slip, where adding weights had the greatest effect in reducing slip at a constant speed. Mahmood et al., (2020) indicated that the decrease in tire inflation pressure increases its contact area with the soil and reduces slip and fuel consumption. Reducing tire inflation pressure from (2.45) kg/cm2 to (1.02) kg/cm2 led to reducing the percentage of slip from (26.4%) to (4.39%), and Increasing the added weight from (200) to (500) kg led to reducing the percentage of slipping from (28.81%) to (4.68%).

2. MATERIALS AND METHODS

The experiment was conducted in the autumn agricultural season (2021-2020) for two different locations. The first location had a silty loam texture, while the second location had a clay texture and was 12 km away from the first location. The topography of the field was characterized by its flatness, where the soil texture was analyzed by taking several random samples from the field of experiment at depths of (20-0) cm as shown in Table (1, 2). The field was divided according to the Randomized Complete Block Design (RCBD) (split-split plot) and with three replicates, as the main plots were allocated to soil texture and with two levels (silty loam, clay), and the sub-plots were allocated to tire inflation pressure and at three levels (80, 130, 180 kPa), while The sub-sub plots were assigned to the type of added weight with three levels (control, adding iron wheel cap, adding water). The tractor speed was constant (4.76) km/h, for all treatments, and the length of the treatment was (30) m.

1- Vibration meter: to measure the vibration under the driver's seat. The mentioned device consists of a sensor in the front of which is a magnet through which it is fixed on the surface whose vibration is to be measured. It also contains a wire connecting the sensor and the device that contains a digital screen that shows the vibration values, the unit of measurement ($m.s^{-2}$) as shown in Figure (1).
2- Noise measuring device: to measure the noise level near the driver's ear, which consists of a (LCD) screen, an audio receiver, a response rate (0.5) s, and a unit of measurement (dB) as shown in Figure (2).

Table 1: Volume distribution, soil texture and some physical properties of soil for the first location.

Volume distribution of primary soil contents and soil texture			
Sand %	Clay %	Silt %	Soil texture
28	20	52	Silty loam
Physical properties of soil			

Moisture content	depth (cm)	Bulk density (g/cm3)	Penetration resistance (kN/m²)
14-17	0-5	1.358	458.92
	5-10	1.404	469.85
	10-15	1.448	484.42
	15-20	1.494	539.05

Table 2: Volume distribution, soil texture and some physical properties of soil for the seond location.

Volume distribution of primary soil contents and soil texture			
Sand %	Clay %	Silt %	Soil texture
10.05	51.7	38.25	Clay
Physical properties of soil			
Moisture content	depth (cm)	Bulk density (g/cm3)	Penetration resistance (kN/m²)
14-17	0-5	1.503	579.12
	5-10	1.540	622.22
	10-15	1.576	688.39
	15-20	1.612	764.87

Figure 1: Vibration meter

Figure 2: Noise meter.

3- Fuel consumption:

The fuel consumption was measured by the addition method, where a graduated cylinder was used to add fuel to the fuel tank of the tractor after completing each line of the treatments lines, and it was calculated according to the following equation (Al-Jarrah, 1998; AL-Hashem et al., 2000):

$$FC=\frac{Fca\times 10}{Wp\times L}\times\frac{L}{ha}$$

where:

FC: the amount of fuel consumed per unit area ($L.ha^{-1}$).

Fca: measured amount of fuel consumed (ml).

Wp : actual plowing width (m).

L: the length of the treatment (m).

4- Percentage of Slippage:

Slip: It is the asymmetry between the length of the linear distance to the circumferential distance for a fixed number of revolutions for the driving wheels in the tractor, and the linear distance is usually less than the circumferential distance (Al-Banna, 1990). Slippage was calculated from the following equation (Al-Rahim, 2009):

S = (Vt-Vp)/Vt "×100"

where;

S: percentage of slip .

Vt: theoretical speed (km/h).

Vp: practical speed (km/h).

3. RESULTS AND DISCUSSION

Table (3) shows that there is a significant effect of soil texture on the trait of vibration, where the first location (silty loam) has excelled in recording the lowest value, which amounted to ($18.64\ m.s^{-2}$), while the second location (clay) recorded the highest value, which amounted to ($21.33\ m.s^{-2}$). The reason for this is the difference in soil hardness, resistance to movement, and compression, and this is due to the difference in cohesion strength and the angle of internal friction of the soil for both locations, and these results agree with (Wiley and Turner, 2008; Cutini et al., 2017). It was also shown from the table that the effect of tire inflation pressure was significant on vibration, where the tire inflation pressure (80) kPa was significantly excelled by recording it the lowest value, which amounted to ($19.20\ m/s^2$), followed by inflation pressure (130) kPa, which recorded a value amounted to ($19.98\ m/s^2$), which did not differ significantly from the inflation pressure (180 kPa), which recorded the highest value amounted to ($20.79\ m/s^2$). The reason for this is that decreasing the inflation pressure reduces the stiffness of the tire in contact with the soil, thus reduces the vibrations transmitted from the soil surface to the tractor affecting the driver’s body, and this result agrees with (Butkus and Vasiliauskas, 2016). it was observed from the same table that the effect of the added weight was significant on the vibration trait, where the addition of water to the tires of the rear tractor was significantly excelled by recording it the lowest value amounted to ($18.59\ m/s^2$), followed by iron weights, which recorded a value amounted to ($19.95\ m/s^2$), while the treatment of non-adding weights to the tractor (control) gave the highest value at the bottom of the driver's seat, which amounted to (21.43 m/s^2). The reason for this is that adding weights to the tires increases the stability of the tractor and reduces the vibrations transmitted from the surface of the soil to the driver’s seat, and adding water to the rear tires of the tractor instead of iron weights had a significant effect in reducing vibrations where the water works to dampen the vibrations resulting from the plowing process and these results agree with (Cutini et al., 2010). It is also clear from the same table that there is no significant effect of the interaction between soil texture and tire inflation pressure on the vibration trait, where the lowest value was recorded at the first location (silty loam), with inflation pressure (80) kPa, which amounted to (17.85 m/s^2), while it was recorded the highest value at the second location (clay), with a inflation pressure amounted to (180 kPa), which amounted to (22.35 m/s^2). The reason for this is that the soil texture in the first location and the reduction of tire inflation pressure led to a reduction in the agitation between the tire and the soil, thus reduced the vibrations transmitted from the soil to the tractor. We note from the interaction of soil texture with the added weight that the vibration trait was affected significantly, where the lowest significant value was recorded at the first location (silty loam), with the addition of water to the tractor wheels, which amounted to (17.92 m/s^2), while the highest significant value was recorded at the second location (clay), with no weights added to the tractor (control), which amounted to (23.32 m/s^2). The reason for this is that the addition of weights to the rear wheels of the tractor in addition to the role of the soil texture, which played a major role in increasing the stability of the tractor and reducing the vibrations transmitted to the driver's seat. The interaction of tire pressure with the added weight had no significant effect on the vibration trait, where the treatment of inflation pressure (80 kPa) with the addition of water recorded the lowest value amounted to (18.05 m/s^2), while the highest value was at the interaction treatment between the inflation pressure (180 kPa) and without adding the weights to the tractor (control), which amounted to (22.65 m/s^2), for the aforementioned reasons. The triple interaction of the studied factors did not have any significant effect on the vibration trait, but there was a difference in the values, where the lowest value recorded at the first location with inflation pressure (80 kPa) and adding water to the rear wheels of the tractor, which amounted to (17.21 m/s^2) while the highest value was at the second location, the inflation pressure (180) kPa, and with no weights added to the tractor (control), which amounted to (24.98 m/s^2).

Table 3: Effect of the studied factors and their interactions on the trait of vibration (m/s^2).

Soil texture	Tire inflation pressure (kPa)	Type of adding weight			Interaction of Soil texture with tire inflation pressure	Average of soil texture
		Control	Iron weights	Adding the water		
Silty loam	80	18.53	17.80	17.21	17.85	b18.64
	130	19.79	18.69	18.10	18.86	
	180	20.31	18.91	18.45	19.22	
Clay	80	22.24	20.54	18.88	20.55	a 21.33
	130	22.74	21.26	19.29	21.10	
	180	24.98	22.48	19.59	22.35	
Interaction of soil texture with the type of adding weight	Silty loam	c19.54	cd18.47	d17.92	Average of tire inflation pressure	
	Clay	a23.32	b21.43	c19.25		
Interaction tire inflation	80	20.38	19.17	18.05	b 19.20	

pressure with the type of adding weight	130	21.27	19.98	18.70	ab19.98
	180	22.65	20.69	19.02	a20.79
Average type of adding weight		a21.43	b19.95	c18.59	

The lowest value is the better.

Table (4) shows that the soil texture has no significant effect on the trait of noise, where the first location (silty loam) achieved the lowest value amounted to (96.27 dB), while the second location (clay) achieved the highest value amounted to (96.88 dB). The reason is that the soil texture in the first location was less solid than the second location, and this difference had a small effect on the decrease in the noise level resulted from the mechanical unit (tractor and machine) during the plowing process, these results agree with (Vallone et al., 2016). It was found from the same table that the effect of tire inflation pressure was significant in the trait of noise, where the tire inflation pressure (80 kPa) was significantly excelled by recording it the lowest value amounted to (95.69 dB), followed by tire inflation pressure (130 kPa), which recorded a value amounted to (96.69 dB), which It did not differ significantly from the inflation pressure (180 kPa), which recorded the highest value amounted to (97.34 dB). The reason for this is that reducing the inflation pressure of the rear tires of the tractor leads to an increase in the area of contact with the soil surface, as well as an increase in the flexibility of the tire, which led to a decrease in the noise level resulting from the movement of the tractor and the machine in the field. We note from the same table that the effect of the adding weight was significant in the trait of noise, where the addition of water to the rear tire of the tractor was significantly excelled by recording it the lowest value amounted to (95.60 dB), followed by the iron weights, which recorded a value amounted to (96.72 dB), which did not differ significantly from the treatment of non-adding weights to the tractor (control), which recorded the highest value amounted to (97.40 dB). The reason for this may be due to the fact that adding weight to the rear tire led to increasing the stability of the tractor and reducing the noise level caused by the movement of the tractor. It was found from the table that the noise trait was not significantly affected at the interaction between soil textures and tire inflation pressure, where the lowest value recorded at the interaction between the first location (silty loam) and inflation pressure (80 kPa), which amounted to (94.96 dB), while the highest value recorded at the interaction between the second location (clay) and a tire inflation pressure (180 kPa), which amounted to (97.47 dB). The interaction of soil texture and the adding weight had no significant effect on the noise trait, where the lowest value recorded at the interaction between the first location (silty loam) and adding water to the tire of the tractor, which amounted to (95.20 dB), while the highest value was at the interaction between the second location (clay) and non-adding the weights to the tractor (control), which amounted to (97.86 dB). The trait of noise was not significantly affected by the interaction between inflation pressure and the type of adding weight, where the inflation pressure (80 kPa) with the adding of water recorded the lowest value amounted to (94.41 dB), while the highest value was at the inflation pressure (180 kPa) with non-adding the weights of the tractor (control), which amounted to (97.76 dB). The triple interaction of the studied factors did not have any significant effect on the noise trait, while there was a difference in the values, where the lowest value was at the first location with the inflation pressure (80 kPa) and adding water to the rear tire of the tractor, which amounted to (93.47 dB), and the highest value was at the interaction between the second location, Inflation pressure (180 kPa) and non- adding weights to the tractor (control), which amounted to (97.93 dB).

Table 4: Effect of the studied factors and their interactions on the trait of noise (dB).

Soil texture	Tire inflation	Type of adding weight	Interaction of Soil	Average of

	pressure (kPa)	Control	Iron weights	Adding the water	texture with tire inflation pressure	soil texture
Silty loam	80	96.21	95.19	93.47	94.96	96.27
	130	97.04	97.35	95.53	96.64	
	180	97.60	97.46	96.59	97.22	
Clay	80	97.78	96.12	95.35	96.41	96.88
	130	97.86	96.52	95.84	96.74	
	180	97.93	97.68	96.80	97.47	
Interaction of soil texture with the type of adding weight	Silty loam	96.95	96.67	95.20	Average of tire inflation pressure	
	Clay	97.86	96.77	96.00		
Interaction tire inflation pressure with the type of adding weight	80	97.00	95.65	94.41	b95.69	
	130	97.45	96.94	95.68	a96.69	
	180	97.76	97.57	96.70	a97.34	
Average type of adding weight		a97.40	a96.72	b95.60		

The lowest value is the better.

Table (5) shows that there is a significant effect of soil texture on fuel consumption, where the first location (silty loam) was significantly excelled by recording the lowest value amounted to (26.27 $L.ha^{-1}$), while the second location (clay) recorded the highest value amounted to (32.05 $L.ha^{-1}$). The reason for this is that the physical properties of the soil in the first location and its resistance to the plowing process were less than that of the second location, which led to a decrease in the energy required to complete the process of plowing and dismantling the soil, thus reducing fuel consumption. this result agrees with (Aday et al., 2006). It was also shown from the same table that the effect of tire inflation pressure was significant on fuel consumption, where the tire inflation pressure (80 kPa) was significantly excelled by recording it the lowest value amounted to (23.62 $L.ha^{-1}$), followed by the inflation pressure (130 kPa), which recorded a value amounted to (28.07 $L.ha^{-1}$), while the inflation pressure (180 kPa) recorded the highest value amounted to (35.81 $L.ha^{-1}$). The reason is decreasing the inflation pressure of the rear tires for the tractor increases its contact area with the soil, which leads to a reduction in the percentage of slip, thus reduces fuel consumption. this result agrees with (Wiley and Turner, 2008). We observe from the same table that the effect of the adding weight was significant on the fuel consumption, where the adding water to the rear tire of the tractor was significantly excelled by recording it the lowest value amounted to (24.43 $L.ha^{-1}$), which did not differ significantly from the treatment of iron weights, which recorded a value amounted to (24.48 $L.ha^{-1}$), While the treatment of non-adding weights to the tractor (control) recorded the highest value amounted to (38.58 $L.ha^{-1}$). The reason is due to the fact that adding weights to the rear tire of the tractor increases the time of contact of the tire with the soil surface, which increases the dynamic stability of the tractor tires, which led to a decrease in the percentage of slip and fuel consumption. this result agrees with (Jassim and Al Shujairi, 2010). It is clear from the same table that the fuel consumption was not significantly affected by the interaction between soil texture and tire inflation pressure, where the lowest value was at the interaction between the first location (silty loam) and inflation pressure (80 kPa), which amounted to (21.80 $L.ha^{-1}$), while it was recorded the highest value at the interaction between the second location (clay) and inflation pressure (180 kPa), which amounted to (39.09 $L.ha^{-1}$). We observe from the interaction between soil texture and adding weight that the fuel consumption was not significantly affected, where the lowest value was at the interaction between the first location (silty loam) and adding water to the tire of the tractor, which amounted to (21.45 $L.ha^{-1}$), while the highest value was at the interaction between the second location (clay) and non-adding weights to the tractor (control), which amounted to (41.49 $L.ha^{-1}$). This trait was not significantly affected by the interaction between tire pressure and the type of adding weight, where the interaction between inflation pressure (80) kPa and adding water gave the lowest value amounted to (18.84 $L.ha^{-1}$), while the highest value was at the interaction between the inflation pressure (180 kPa) and non-adding weights to the tractor (control), which amounted to (46.51 $L.ha^{-1}$). We observe that the fuel consumption was significantly affected by the triple interaction of the studied factors, where the lowest significant value was at the triple interaction between the second location (clay), inflation pressure (80) kPa, and adding water to the rear tire of the tractor, which amounted to (18.81 $L.ha^{-1}$), while the highest significant value was at the triple interaction between the first location (silty loam), inflation pressure (180 kPa), and non-adding weights to the tractor (control) which amounted to (49.92 $L.ha^{-1}$).

Table 5: Effect of the studied factors and their interactions on the trait of fuel consumption ($L.ha^{-1}$).

Soil texture	Tire inflation pressure (kPa)	Type of adding weight			Interaction of Soil texture with tire inflation pressure	Average of soil texture
		Control	Iron weights	Adding the water		
Silty loam	80	cd7.62	e18.91	e18.88	21.80	ب26.27
	130	c29.47	de22.32	de21.66	24.49	
	180	a49.92	cde23.86	cde23.82	32.53	
Clay	80	b38.54	e18.93	e18.81	25.43	أ32.05
	130	b42.82	cd26.09	cd26.03	31.65	
	180	b43.09	b36.77	b37.40	39.09	
Interaction of soil texture with the type of adding weight	Silty loam	35.67	21.70	21.45	Average of tire inflation pressure	
	Clay	41.49	27.26	27.41		
Interaction tire inflation pressure with the type of adding weight	80	33.08	18.92	18.84	c23.62	
	130	36.15	d24.21	23.85	b28.07	
	180	46.51	30.31	30.61	a35.81	
Average type of adding weight		a38.58	b24.48	b24.43		

The lowest value is the better.

Table (6) shows that there was a significant effect of soil texture on the percentage of slip, where the second location (clay) has excelled by recording it the lowest value amounted to (7.31)%, while the first location (silty loam) recorded the highest value of the percentage amounted to (18.81 %). The reason is that the soil texture in the first location was of little cohesion, which led to rushing parts of the surface layer for the soil behind the tractor tires and increasing in slippage compared to the second location with a more solid and cohesive clay texture, and this was confirmed by (Al-Banna, 1990). It was also shown from the same table that the effect of tire inflation pressure was significant in the trait of the percentage of slip, where the tire inflation pressure (80 kPa) was significantly excelled by recording it the lowest value amounted to (9.39)%, followed by tire inflation pressure (130 kPa), which recorded (13.06). While the inflation pressure (180 kPa) recorded the highest value amounted to (16.73)%. The reason is that reducing the inflation pressure of the rear tires for the tractor led to an increase in the area of contact with the soil and a decrease in the time period to complete the plowing operations, and this result agrees with (Al-Jarrah, 2011). We observe from the same table that the effect of the adding weight was significant in the percentage of slip, where the adding water to the rear tire of tractor has excelled by recording it the lowest significant value amounted to (10.69)%, which did not differ significantly from the treatment of iron weights, which recorded a value amounted to (11.25)%, while the treatment of non-adding weights for the tractor (control) gave the highest value amounted to (17.25)%. The reason is that adding weights to the rear tire of the tractor increases the cohesion of the soil particles and reduces its displacement behind the driving tire, which leads to reduced slip. These results agree with (Moinar and Shahgholi, 2019). It is clear from the same table that the trait of slip was significantly affected by the interaction between the soil texture and tire inflation pressure, where the lowest significant value was at the interaction between the second location (clay) and the tire inflation pressure (80 kPa), which amounted to (5.97)%, which did not differ significantly with the rest of the pressures for the same location, While the highest significant value was at the interaction between the first location (silty loam) and tire inflation pressure (180 kPa), which amounted to (25.06)%. we observe from the interaction between the soil texture and the adding weight that the trait of the percentage of slip was significantly affected, where the lowest significant value was at the interaction between the second location (clay) and adding water to the tractor tires, which amounted to (6.37)%, while the highest significant value was at the interaction between the first location (silty loam) and non-adding weights to the tractor (control), which amounted to (25.44)%. The slip trait was not significantly affected by the interaction between tire inflation pressure and the type of adding weight, despite the presence of differences in the values. The interaction between tire inflation pressure (80 kPa) and adding water recorded the lowest value amounted to (7.98)%, while the highest value was at the interaction between tire inflation pressure (180 kPa) and non-adding weights to the tractor (control), which amounted to (21.57)%. This trait was not affected by the triple interaction of the studied factors, where triple interaction between the second location (clay), tire inflation pressure (80 kPa), and adding water to the rear tire of the tractor recorded the lowest value amounted to (4.83)%, while the triple interaction between the first location (silty loam), tire inflation pressure (180 kPa), and non-adding weights to the tractor (control) gave the highest value amounted to (32.98%).

Table 6: Effect of the studied factors and their interactions on the trait of the percentage of slip (%).

Soil texture	Tire inflation pressure (kPa)	Type of adding weight			Interaction of Soil texture with tire inflation pressure	Average of soil texture
		Control	Iron weights	Adding the water		
Silty loam	80	16.03	11.27	11.13	c12.81	a18.81
	130	27.31	15.12	13.23	b18.55	
	180	32.98	21.56	20.65	a25.06	
Clay	80	8.05	5.04	4.83	d5.97	b7.31
	130	8.96	6.93	6.79	d7.56	
	180	10.15	7.56	7.49	d8.40	
Interaction of soil texture with the type of adding weight	Silty loam	a25.44	b15.98	b15.00	Average of tire inflation pressure	
	Clay	c9.05	d6.51	d6.37		
Interaction tire inflation	80	12.04	8.16	7.98	c9.39	

pressure with the type of adding weight	130	18.14	11.03	10.01	b13.06
	180	21.57	14.56	14.07	a16.73
Average type of adding weight		a17.25	b11.25	b10.69	

The lowest value is the better.

4. CONCLUSIONS

1- The silty loam soil gave the best values for vibration and fuel consumption, while clay soil gave the best value for the percentage of slip. Inflation pressure (80 kPa) has also excelled by obtaining the best values for all traits in both locations.
2- The adding weights to the tractor tires gave the best values for (vibration, noise, fuel consumption, and percentage of slip).
3- The treatment of adding water to tires was distinguished from the treatment of adding iron weights in reducing vibration and noise by a greater percentage, where adding water to tires reduced both vibration and noise by (13.25% and 1.85) %, respectively, while they decreased by (6.91) % and (0.70) % when adding iron weights compared to the treatment of non-adding weights to tires.

5. RECOMMENDATIONS

1- The study recommends using tire inflation pressure (80 kPa) to give it better results in both locations compared to the other studied pressures.
2- The study recommends adding water to the tractor tires instead of the standard weights assigned to each tractor because it gave better results, especially for vibration and noise.

Acknowledgment

The authors would like to thank the University of Mosul for their support in completing this research. The authors also thank the Department of Mechanics and the Department of Civil Engineering at the University of Mosul for their cooperation in providing some equipment that was used in this research.

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