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RESEARCH ARTICLE

Different blends of biodiesel, bioethanol, diesel and noise pollution emitted by stationary and moving MF285 tractor

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Abstract
Given the significance of the relationships between human beings, environment, machines and ergonomics as well as the necessity of using renewable fuels, the present study aimed to investigate the effects of different blends of biodiesel, bioethanol and diesel on noise pollution emitted by a MF285 tractor in stationary and moving modes by the aid of statistical methods. In this respect, the emitted noise was measured using the noise dosimeters and sound level meters in the driver and the bystander's positions, at 1000, 1600 and 2000 RPM in both stationary and moving modes. Then, nine fuel blends of biodiesel, bioethanol and diesel with different volumetric percentages as well as pure diesel were studied. To study the effects of key factors on noise pollution, the factorial experiment was conducted in the form of a completely randomized design, followed by the application of the SPSS Statistics Software Version 19.0. The fuel type nearly affected the noise pollution at the level of 5%, and other factors such as engine rotational speed and the fuel type-engine rotational speed interaction influenced it at the level of 1%. In both the driver and bystander's positions, the minimum and maximum noise pollution occurred at 1000 and 2000 RPM, respectively. The effects of gears along with their twofold and threefold interaction with other factors were not significant. Finally, the results of the present study demonstrated that the $B_{25}E_4D_{71}$ fuel, composed of 25% biodiesel and 4% bioethanol, had the lowest noise pollution.

Keywords Noise pollution · Safety · Bioethanol · Biodiesel · MF285 tractor

Introduction

Due to the importance of agricultural machinery and tractors on farms as well as agricultural mechanization, the users and farm laborers give special attention to the safety issues and occupational health arising from working with these machines, including the noise pollution emitted by these tools [1, 2]. Excessive noise can adversely affect the health of human beings, namely permanent and temporary hearing loss, visual impairment, improperly functioning balance system (e.g., dizziness, nausea, and difficulty walking), neurological and psychological disorders, decreased work efficiency, growing risk of accidents, and physiological outcomes (e.g., fast heartbeat, blood pressure and respiratory rate) [3]. Noise pollution encompasses a wide range of engineering applications and can be examined from different aspects, such as noise emitted by various types of engines which are often used as power sources in agriculture. The source of most noise pollution in tractors ensues from the ignition and the structure of the engine itself. Besides, ignition depends on the type of fuel and the design of the combustion chamber. The allowable sound level produced by tractors was studied by Stayner (1988) [4]. In addition, in a study conducted by Celen & Arin (2003) on the intensity of noise pollution emitted by tractors, it was concluded that the highest and lowest intensity was near the exhaust and the driver's seat, respectively [5]. In another study, the sources of noise were explored in front of a diesel engine, and it was concluded that the sources of sounds could be identified through measuring their intensity [6]. Pruvost et al. (2009) distinguished between the noise resulting from

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the combustion and the noise stemmed from the mechanical processes in engines, and it was revealed that both the engine revolution and the engine load would influence the intensity of the resultant noise. However, due to the dwindling fossil energy resources, rising prices of oil, and its derivatives on the one hand and the growing demand for energy as well as the growing environmental pollution caused by the combustion of fossil fuels on the other hand, most governments are nowadays striving to provide alternative sources of energy that pose less pollution to the environment and are cost-effective [7]. Biodiesel is one of the clean and renewable energies that can be used as a suitable substitute for fossil fuels [8].

Some studies have been conducted on the use of different blends of biodiesel, bioethanol, and diesel in engines. Performance and combustion characteristics of different biodiesel–diesel–methanol/ethanol blends in diesel engine have been investigated as well [9–17].

In a research, the effects of different blends of petrol and ethanol on the vibrations of cylinder blocks and the noise of spark-ignition engines were investigated. The results showed that with the increase of ethanol in the blend, the engine's vibrations and noise increased, particularly within the range of 1500 to 2500 RPM [18].

In another study, authors remarked that using ethanol and diesel blends could enahnce the thermal efficiency of engines and diminish the concentration of particulates and NOx in the air [19]. Rahimi et al. (2009) used a blend of diesel, biodiesel fuel from sunflower oil, and ethanol extracted from waste potatoes. The results revealed that, once applying this fuel composition, the maximum power and torque of engines were slightly decreased and the mean of the specific fuel increased [20]. In another study conducted by Subbaiah et al. (2010), the biodiesel produced from the rice bran oil was combined with diesel and ethanol, and the obtained fuel was used in a diesel engine. The results demonstrated that the highest thermal efficiency was observed when the concentration of ethanol was 15% in the blend of biodiesel, bioethanol, and diesel. With the increase of ethanol volume, the concentrations of carbon monoxide and smoke reduced dramatically whereas hydrocarbons, nitrogen oxides, and carbon dioxide increased such that the concentration of hydrocarbons was still less than diesel [21, 22].

In another study carried out by Zhang et al., the effect of using fuel blends of waste oil biodiesel and diesel on the performance of a four-cylinder diesel engine was investigated. The results showed that the engine performance at high biodiesel percentages was slightly low where it did not generally make much difference in comparison to the use of pure diesel fuel [23]. Torregrosa et al. [24] prepared fuel blends of soybean and rapeseed biodiesel with diesel and investigated the effect of using fuel blends on engine performance and noise and air pollution. The results showed that with increasing biodiesel percentage, although the noise pollution caused by combustion decreased, there was slight enhancement of the engine performance compared to using pure diesel. Patel et al. developed three different diesel fuels, a pure Jatropha biodiesel, and a combination of 20% biodiesel Jatropha and diesel and investigated their effects on single-cylinder engine performance, noise pollution, and vibrations. The results showed that the performance of the engine was not changed, while the noise pollution caused by the engine ignition in the pure biodiesel was the lowest and the noise pollution of the diesel was relatively higher [25, 26]. In a study, biodiesel was produced from mustard and palm oil to be blended with diesel for different mixing ratios. The effect of applying fuel blends on the performance of a four-cylinder engine and noise and air pollution was investigated. The results of this study revealed that although biodiesel fuel blend provided a slight change in engine performance compared to pure diesel, noise pollution decreased with increasing biodiesel percentage [27–29].

Using diesel mixture with biodiesel produced from palm and olive oil with different ratios of 20% and 50% reduced the noise pollution of diesel engine in comparison to pure diesel fuel [30]. In a study conducted by Li et al. [31], different biodiesel and diesel blends were used in a four-cylinder engine. The obtained results demonstrated that as the biodiesel percentage increases, noise pollution increased. In other words, increasing biodiesel by 20%, noise pollution was escalated by about 0.5 db and vibrations decreased by about 0.25 db on the contrary. In a study that examined the effect of using biodiesel and diesel blends on the performance of a city-car engine, it was shown that the use of different biodiesel blends, despite reducing air pollution, did not significantly change the performance of the engine compared to pure diesel [32]. In another study, the noise pollution generated in the MF285 tractor was examined for using fuel blends of diesel, biodiesel, and bio-ethanol. The results showed that noise pollution was declined by augmenting biodiesel percentage [33].

Because of environmental pollution triggered by fossil fuels and their non-renewable fossils, the use of clean fuels, such as biodiesel, is of great importance and interest [34]. Vegetable fuels are generally less polluting than fossil fuels and can effortlessly be produced from plant material residues. Even waste and debris from foods and distilled materials from the food industry as well as sewage can be a good source of vegetable fuels [35]. A thorough investigation is needed into the combination of biodiesel, bioethanol, and diesel as a fuel in the tractor, due to the changes in fuel characteristics, and its effect on combustion and engine performance [23]. The use of biodiesel fuel blends in diesel engines has had modest changes in engine performance than that of pure diesel [23–29]. Diesel engines working with biodiesel blends has lower air pollution (Carbon monoxide, Unburned hydrocarbons, soot, and other pollutants) compared to diesel engines with diesel fuel [36]. Another indicator of the evaluation of biodiesel fuel blends is the noise pollution generated by the tractor engine. Because farmers work a lot of hours during a day with tractors, the emitted noise pollution will have a severely negative effect on their health as a result. However, not many studies have been conducted on the effects of biodiesel, bioethanol, and diesel on the noise pollution emitted by tractors. Furthermore, due to the importance of the concepts of replacing fossil fuels with renewable fuels, the rate of using tractors in agricultural activities, and farmers' health, conducting some comprehensive studies seem to be substantially essential in this respect. So, the present study aims to investigate the effects of different blends of biodiesel, bioethanol, and diesel on noise pollution emitted by a MF285 Tractor in stationary and moving modes by the aid of statistical methods so as to introduce the well-suited fuel blend with the lowest noise pollution.

Material and methods

For measuring the noise emitted by the tractor, distance from obstacles (buildings, trees, etc.) was more than 20 m [5, 22]. In Fig. 1, a 20-m-long track is displayed along which a MF285 tractor is moving with the specified engine rotational speed and gears. The sound level meter was located in the middle of the track at an elevation of 1.2 m from the ground and a distance of two meters from the central axis of the tractor, i.e. the sound level meter was 50 cm away from the headlights of the tractor [37–40]. Figure 2 depicts the MF285 tractor, the noise dosimeter attached to the collar of the driver, and the sound level meter sitting on a tripod. The image was taken at Razi University, Faculty of Agriculture, and the participants in the research (driver and bystander) were technical experts recruited for this study.

The temperature was between −5 and 30 °C, the wind speed was less than five meters per second where the user was standing, and other climatic conditions were set so that the measurements were not affected. Besides, the levels of ambient and wind sounds were at least 10 dB lower than the sound level measured during the test [22].

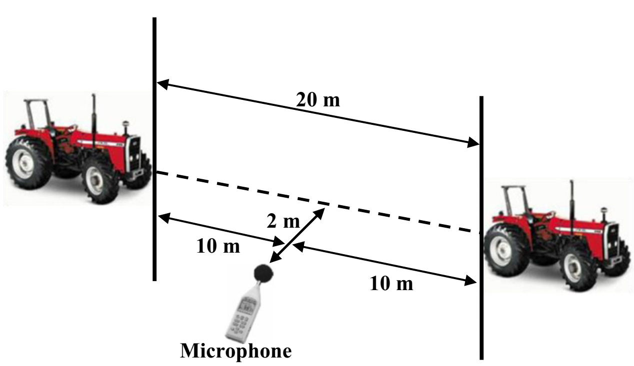

Fig. 1 Layout of the test area -Microphone positions

Fig. 2 The Images of the MF285 tractor and the Microphones

Table 1 lists the noise sources available in the tractor. Ranking of the noise pollution level is conducted within two columns, namely 800 rpm-load free and 2200 rpm-full load. As shown in the table, in the firing and Motoring modes, the engine set is the major source of noise pollution. This helps us determine the cause of noise pollution increases/decrease in tractors under different circumstances [41].

The tractor used in the present study was subjected to technical inspections and periodic maintenance. The tractor ran in accordance with the manufacturer's specifications and instructions. In addition, the engine, power

Table 1 Noise level ranking at the tractor [41]

Noise Source	2200 rpm – Full Load	800 rpm – No Load
Firing		
Complete engine	1	1
Exhaust	2	2
Combustion	3	*
Intake	4	3
Motoring		
Engine mechanical	1	1
Pistons	2	3
Cooling fan	3	7
Front gear set	4	4
Valve train	5	5
Injection System	6	2
Power steering pump	7	6
Generator	8	9
Main bearing	9	10
Water pump	10	8
Lube pump	*	*

Ranking of 1 is highest noise level

*Indicates noise level not discernible

transmission, and hydraulic systems operated long enough to reach a stable temperature prior to measurements.

To make measurements, the sound level meter was placed along the arm at an elevation to reach the ears. A typical sound level meter (SLM) is comprised of a microphone, electrical circuits, and an indicator. The microphone converts the minor changes in the air pressure caused by noise into electrical signals. These messages were then modified by an electric circuit and were finally displayed in the form of sound levels in dB. Also, SLM shows and measures only the momentary sound pressure levels in a given position where the sound levels are consistent. However, to determine the average contacts of an individual with sounds in a shift, using the conventional sound level meters is mistaken if applied in workplaces where there are non-uniform and periodic hitting sounds. The viable alternative to this situation is to use noise dosimeters that are small and lightweight instruments capable of being attached to the waist of the user, and its microphone is attached to the user's collar near his ears.

The sound levels are saved and averaged by noise dosimeters. Also, this instrument has many practical applications in industries where the levels of sounds are variable during the working time and the workforce changes positions very often. At least three measurements were taken after 10 s of steady operation of the engine in each of the positions of the microphone and in each of the operating conditions, and any of the sound peaks clearly outside the range of the typical sounds were eliminated [22].

In this study, the sound levels were studied in the driver and the bystander's positions. To measure the sound levels in the driver and the bystander's positions, the noise dosimeters and sound level meters were employed, respectively. Furthermore, prior to data acquisition (DAQ), the aforesaid instruments were calibrated. Then, nine different fuel blends were prepared from biodiesel, bioethanol, and diesel, namely B5E2D93, B5E4D91, B5E6D89, B15E2D83, B15E4D81, B15E6D79, B25E2D73, B25E4D71, B25E6D69. Further, B0E0D100, a pure diesel fuel, was considered the control element. Properties of the fuel blends obtained in accordance with the ASTM test standards are shown in Table 2. Cetane number, density, heat of combustion, flash point, and pour point were tested by following ASTM D976, D4052, D240, D56 and D97, respectively [33, 42–44].

To investigate the effects of different blends of biodiesel fuels on noise pollution emitted by a MF285 tractor, the factorial experiment was employed in the form of a completely randomized design. Moreover, all experiments were conducted at 1000, 1600 and 2000 RPM in both stationary and moving modes. In the stationary mode, the factorial experiment was performed with fuel and engine rotational speed, whereas in the latter, the factorial experiment was carried out with three factors including fuel, engine rotational speed, and gears. The noise pollution was measured in a MF285 tractor driven in the 2nd and 3rd gears and each of the experiments were repeated three times. Additionally, the Duncan's multiple range test (MRT) was used for comparing the means of factors and the SPSS Statistics Software Version 19.0 was employed for data analysis.

Table 2 Properties of fuel blends from diesel, biodiesel and bio-ethanol

Fuel Blends	Oxygen content (wt%)	Heat of combustion (MJ/kg)	Density (g/ml)	Pour point (°C)	Flash point (°C)	Cetane number
$B_5E_2D_{93}$	1.2	44.3	0.844	2	71	46
$B_5E_4D_{91}$	1.9	44.0	0.844	−1	70	45
$B_5E_6D_{89}$	2.6	43.6	0.841	−3	69	44
$B_{15}E_2D_{83}$	2.3	43.7	0.847	2	77	46
$B_{15}E_4D_{81}$	3.0	43.4	0.845	0	76	45
$B_{15}E_6D_{79}$	3.7	43.0	0.845	−3	74	45
$B_{25}E_2D_{73}$	3.4	43.1	0.851	2	83	47
$B_{25}E_4D_{71}$	4.1	42.8	0.851	0	82	46
$B_{25}E_6D_{69}$	4.8	42.4	0.849	−3	80	45
D_{100}	0	45	0.843	4	69	46
B_{100}	10.8	39	0.878	7	128	52
E_{100}	34.8	27	0.795	−117	13	9

Results & discussion

In general, the experiments were conducted in both stationary and moving modes and data were analyzed separately.

The stationary mode

The results of the variance analysis of the noise pollution in decibels (dB) emitted by the stationary MF285 tractor in the driver and bystander's positions are shown in Table 3.

Accordingly, the effect of fuel type on noise pollution in the driver position was weighty at the level of 5%, whereas the effects of engine rotational speed and the interaction between fuel type and engine rotational speed were significant at the level of 1%. Moreover, in the bystander's position, the effects of fuel type, engine rotational speed, and their interactions were meaningful at the level of 1%.

The results of comparing the means of noise pollution emitted by the stationary MF285 tractor at different levels of fuel type with Duncan's test are detailed in Table 4. The results indicated that in the driver's position, the pure diesel fuel $B_0E_0D_{100}$ produced the least noise pollution. In addition, $B_{25}E_4D_{71}$, $B_{25}E_6D_{69}$, and $B_{25}E_2D_{73}$ received the next rankings in this regard, and they were made of 25% of biodiesel and 4, 6 and 2% of bioethanol, respectively.

Table 3 The variance analysis of the noise pollution emitted by the stationary MF285 tractor in the driver and bystander's positions

Change source	df	MSE	
		driver position	Bystander's position
Fuel type	9	0.291*	5.610**
Engine speed	2	560.217**	730.301**
Fuel*speed	18	0.539**	0.630**
Error	60	0.108	0.054
Total	89		

*: significant at level 5% - **: significant at level 5%

However, in the bystander's position, the lowest noise pollution was produced by $B_{25}E_4D_{71}$ fuel. Moreover, $B_{25}E_6D_{69}$ fuel, made of 25% of biodiesel and 6% of bioethanol, was ranked second in this regard.

Therefore, in both the driver and bystander's positions, the $B_{25}E_4D_{71}$fuel was identified as the blend with producing the least noise pollution. By increasing the percentage of biodiesel in the fuel blend, the noise pollution is reduced that concurs with the results of other studies [24, 27–29, 33] whereas not agreeing with the results obtained by Li et al. [31].

Table 4 Comparing the means of noise pollution emitted by the stationary MF285 tractor at various levels of fuel

Fuel number	Fuel type	The average of noise pollution
Driver position		
10	$B_0E_0D_{100}$	90.700 ^{a}
8	$B_{25}E_4D_{71}$	90.844 ^{ab}
9	$B_{25}E_6D_{69}$	90.889 ^{ab}
7	$B_{25}E_2D_{73}$	91.000 ^{abc}
6	$B_{15}E_6D_{79}$	91.011 ^{abc}
2	$B_5E_4D_{91}$	91.04 ^{abc}
1	$B_5E_2D_{93}$	91.078 ^{bc}
4	$B_{15}E_2D_{83}$	91.178 ^{bc}
3	$B_5E_6D_{89}$	91.244 ^{c}
5	$B_{15}E_4D_{81}$	91.267 ^{c}
Bystander's position		
8	$B_{25}E_4D_{71}$	95.478 ^{a}
9	$B_{25}E_6D_{69}$	95.555 ^{a}
5	$B_{15}E_4D_{81}$	95.855 ^{b}
7	$B_{25}E_2D_{73}$	96.011 ^{bc}
6	$B_{15}E_6D_{79}$	96.189 ^{c}
10	$B_0E_0D_{100}$	96.311 ^{cd}
3	$B_5E_6D_{89}$	96.500 ^{d}
4	$B_{15}E_2D_{83}$	96.600 ^{d}
1	$B_5E_2D_{93}$	97.711 ^{e}
2	$B_5E_4D_{91}$	97.733 ^{e}

The similar letters in each column represent the insignificance of the difference between the values mentioned in the respective columns

Increased ethanol to diesel fuel reduces cetane number and increases ignition delay that could eventually lead to an increase in cylinder pressure [31]. Since the cylinder pressure and distribution of pressure waves have a direct effect on the vibration of the engine block [45], increasing the amount of ethanol from 4% to 6% augments the motor vibration and increases the noise pollution. However, an increase in the amount of ethanol from 2% to 4% poses a very slight reduction in engine vibration and noise pollution, which seems to be attributed to the effect of the interaction of compounded biodiesel. Other researchers have shown that adding ethanol to diesel can reduce engine noise at low engine rotational speeds, while increasing it at high engine rotational speeds [46].

According to Table 4, the average noise pollution in the driver's position was lower than that in the bystander's. Since the bystander was located at a distance of 0.5 m from the front wheel of tractor, the distance of the driver from the engine was a little farther than that of the bystander and, based on the acoustic theory; there is less noise pollution in the driver's position. In addition, there are many parts of the tractor body between the driver and engine that obstruct the emitted noise to some extent, whereas there is nothing between the bystander and the engine acting as obstacles.

Table 5 presents the results of comparing the means of noise pollution emitted by the stationary MF285 tractor at different levels of engine rotational speed with Duncan's test at the level of 1%. In both driver and bystander's positions, the lowest and highest noise pollution belonged to 1000 and 2000 RPM, respectively. Furthermore, the differences between the noise pollution at different levels of the engine rotational speed were significant resulting from the rise in the number of ignitions per minute by augmenting the engine rotational speed, followed by an increase in the movement of various parts of the tractor engine leading to higher noise pollution.

The means of the noise pollution emitted by a stationary MF285 tractor in the driver and bystander's positions, for different fuels and at different speeds are shown separately in Fig. 3. In fact, this figure shows the effect of interaction between fuel type and engine rotational speed. The results revealed that, in the driver's position, $B_{25}E_6D_{69}$ (# 9) and then $B_{25}E_4D_{71}$ (# 8) produced the lowest noise pollution at 2000 RPM. Moreover, $B_5E_4D_{91}$ (# 2) at 1600 RPM and $B_{25}E_2D_{73}$ (# 7) at 1000 RPM produced the lowest noise pollution. However, in the

Table 5 Comparing the means of noise pollution emitted by the stationary MF285 tractor at various levels of engine rotational speeds

Engine speed (rpm)	Driver position	Bystander's position
1000	86.187 ^{a}	91.250 ^{a}
1600	91.440 ^{b}	96.847 ^{b}
2000	95.460 ^{c}	101.087 ^{c}

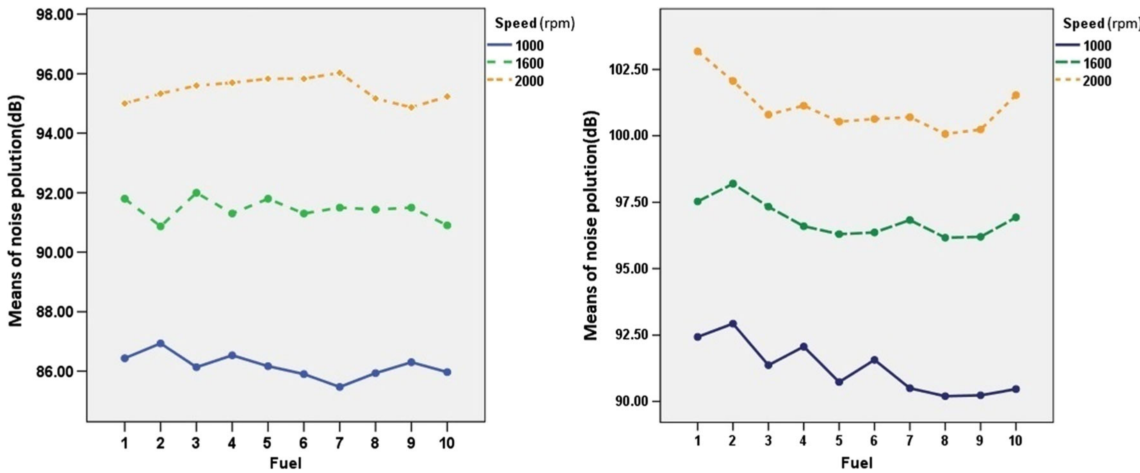

Fig. 3 The means of noise pollution emitted by the stationary MF285 tractor at various levels of fuels and engine rotational speeds: in the driver (left-hand side) and bystander's positions (right-hand side)

bystander's position, $B_{25}E_4D_{71}$ fuel (# 8) generated the lowest noise pollution at three engine rotational speeds.

The moving mode

Having considered the fuel type, engine rotational speed, and gears, the results of the variance analysis of the noise pollution emitted by the moving MF285 tractor were shown in the driver and bystander's positions (see Table 6). According to these results, in the driver position, the effects of fuel type on noise pollution were significant at the level of 5%, whereas the effects of engine rotational speed, gears, and the interaction between fuel type and engine rotational speed were significant at the level of 1%. However, the interaction between fuel type and gears as well as the interaction between engine rotational speed and gears were negligible. The triple interactions of fuel type, engine rotational speed, and gears were considerable at the level of 5%. Besides, in the bystander's position, the effects of fuel type, engine rotational speed and their interaction were noticeable at the level of 1%. However, the effects of gears and its double and triple interactions with other factors were insignificant.

Comparing the means of noise pollution for different fuels in the driver and bystander's positions are shown in Table 7. In

Table 6 The variance analysis of the noise pollution emitted by the moving MF285 tractor in the driver and bystander's positions

Change source	df	MSE	
		driver position	Bystander's position
Fuel type	9	0.255 *	1.386 **
Engine speed	1	885.633 **	1173.125 **
Gear	1	1.408 **	0.261 ns
Fuel*Speed	9	0.397 **	0.532 **
Fuel*Gear	9	0.211 ns	0.184 ns
Speed*Gear	9	0.005 ns	0.133 ns
Fuel*Speed*Gear	9	0.234 *	1.008 ns
Error	80	0.114	0.724
total	119		

*: significant at level 5% - **: significant at level 5% - ns: not significant

Table 7 Comparing the means of noise pollution emitted by the moving MF285 tractor at various levels of fuel

Fuel number	Fuel type	The average of noise pollution
Driver position		
5	$B_{15}E_4D_{81}$	88.300 a
1	$B_5E_2D_{93}$	88.358 a
4	$B_{15}E_2D_{83}$	88.375 a
10	$B_0E_0D_{100}$	88.383 a
6	$B_{15}E_6D_{79}$	88.392 a
9	$B_{25}E_6D_{69}$	88.417 ab
3	$B_5E_6D_{89}$	88.425 ab
7	$B_{25}E_2D_{73}$	88.542 abc
8	$B_{25}E_4D_{71}$	88.700 bc
2	$B_5E_4D_{91}$	88.725 c
Bystander's position		
1	$B_5E_2D_{93}$	92.403 a
7	$B_{25}E_2D_{73}$	92.950 b
9	$B_{25}E_6D_{69}$	92.992 b
6	$B_{15}E_6D_{79}$	93.117 bc
8	$B_{25}E_4D_{71}$	93.283 cd
3	$B_5E_6D_{89}$	93.342 cde
2	$B_5E_4D_{91}$	93.375 de
5	$B_{15}E_4D_{81}$	93.433 de
4	$B_{15}E_2D_{83}$	93.433 de
10	$B_0E_0D_{100}$	93.567 e

The similar letters in each column represent the insignificance of the difference between the values mentioned in the respective columns

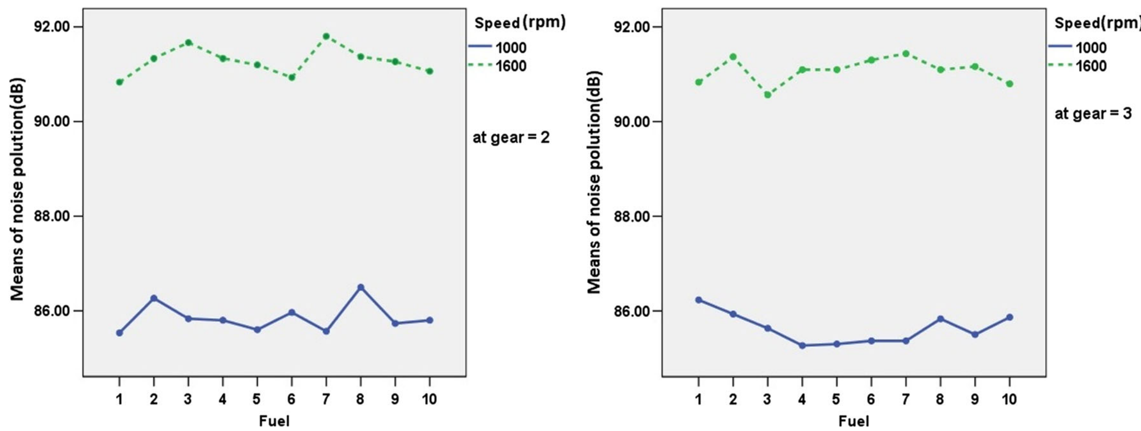

Fig. 4 The means of noise pollution in the moving mode in the 2nd (left-hand side) and 3rd gears (right-hand side) in the driver's position

the moving mode, the average noise pollution was lower in the driver's position than that in the bystander's too.

Figures 4 and 5 show the means of noise pollution in the moving mode, at different gears and rotational speeds for different fuel types in the driver and bystander's positions, respectively. As shown in the figures, in all fuels and in both driver and bystander's positions, the means of noise pollution in the 3rd and 4th gears were lower at 1000 RPM than those at 1600 RPM.

As the engine rotational speed increases, noise pollution increases in both driver and bystander's positions. In other words, in all fuel combinations, with an increase in engine rotational speed, the number of piston movements per unit time increases, followed by an increase in the number of engine cycles in unit time. On the other hand, because each cycle of the engine includes a combustion process, the number of combustion processes increases as well. Therefore, increasing the number of engine cycles and increasing the piston movements per unit time lead to a rise in the vibrations per unit time, raising the resulting noise pollution as well. The result is consistent with the results of previous studies [47–49].

The average noise pollution emitted by the moving MF285 tractor driven, generally in various gears in the driver and bystander's positions, are shown in Fig. 6. The right-hand side figure shows that, in the driver's position, the average noise pollution nearly in all fuels (except for fuel no. 1, i.e., $B_5E_2D_{93}$) was higher in the 2nd gear than the 3rd one which might be attributed to the inappropriateness of the engine rotational speed for the second gear. In other words, if the engine rotational speed is very high for a certain gear, there will be lots of vibrations and noise pollution. However, the left-hand side figure indicates that, in the bystander's position, the average noise pollution was higher in three fuels in the 2nd gear than the 3rd one, whereas it was higher in other fuels in the3rd gear than the 2nd one. However, in general, it seemed that the levels of noise pollution in both gears were alike and were only different from each other as small as one tenth of a decibel.

Table 8 shows the amounts of Mean, standard error and lower-upper confidence limits of acoustic emission (db) for MF285 tractor in all experiments that were done in: 1- All kinds of fuels regardless of engine speed and gear, 2-

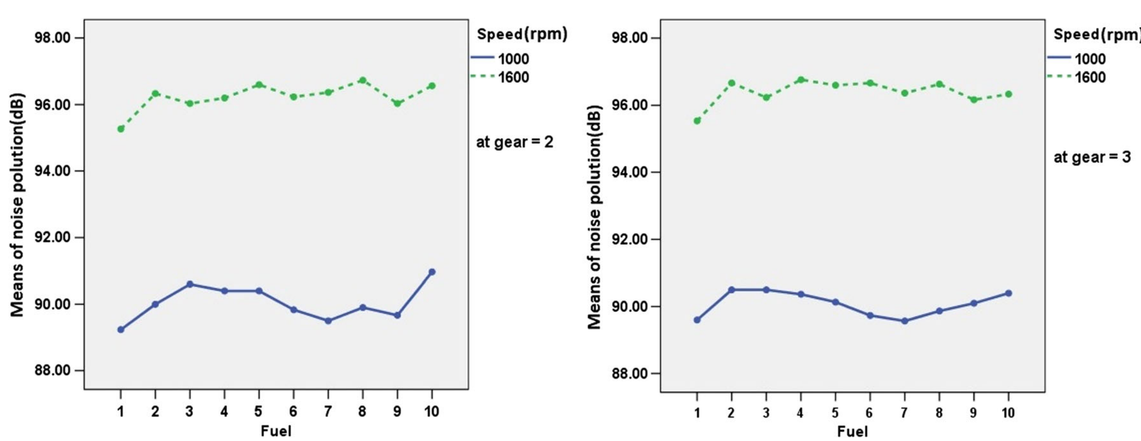

Fig. 5 The means of noise pollution in the moving mode in the 2nd (left-hand side) and 3rd gears (right-hand side) in the bystander's position

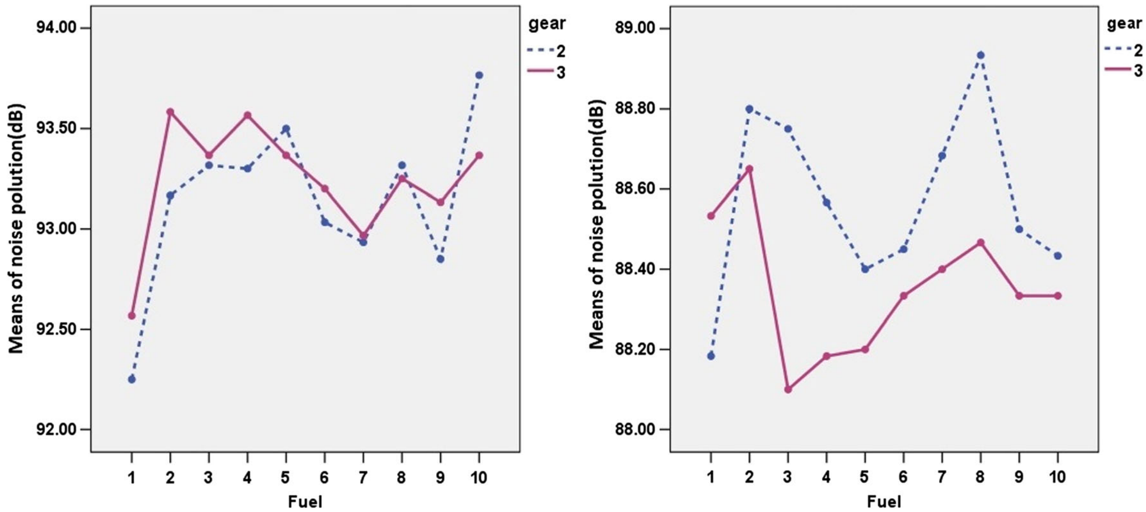

Fig. 6 The average noise pollution in the moving mode generally in various gears in the driver (right-hand side) and bystander's positions (left-hand side)

Table 8 Means compression of acoustic emission (db) with standard error and lower-upper confidence limits

Acoustic Emission (db).		Mean ± Standard Error Lower -Upper Confidence Limits			
		Moving- Bystander	Moving- Driver	Static- Bystander	Static- Driver
Fuel	1	92.41 ± 0.08 92.25–92.56	88.36 ± 0.10 88.17–88.55	97.71 ± 0.08 97.51–97.92	91.08 ± 0.11 90.79–91.37
	2	93.38 ± 0.08 93.22–93.53	88.73 ± 0.10 88.53–88.92	97.73 ± 0.08 97.53–97.94	91.04 ± 0.11 90.75–91.34
	3	93.34 ± 0.08 93.19–93.50	88.43 ± 0.10 88.23–88.62	96.50 ± 0.08 96.29–96.71	91.24 ± 0.11 90.95–91.54
	4	93.43 ± 0.08 93.28–93.59	88.38 ± 0.10 88.18–88.57	96.60 ± 0.08 96.39–96.81	91.18 ± 0.11 90.89–91.47
	5	93.43 ± 0.08 93.28–93.59	88.30 ± 0.10 88.11–88.49	95.86 ± 0.08 95.65–96.06	91.27 ± 0.11 90.98–91.56
	6	93.12 ± 0.08 92.96–93.27	88.39 ± 0.10 88.20–88.59	96.19 ± 0.08 95.98–96.40	91.01 ± 0.11 90.72–91.30
	7	92.95 ± 0.08 92.80–93.11	88.54 ± 0.10 88.35–88.74	96.01 ± 0.08 95.81–96.22	91.00 ± 0.11 90.71–91.29
	8	93.28 ± 0.08 93.13–93.49	88.70 ± 0.10 88.51–88.89	95.48 ± 0.08 95.27–95.68	90.84 ± 0.11 90.55–91.14
	9	92.99 ± 0.08 92.84–93.15	88.42 ± 0.10 88.22–88.61	95.56 ± 0.08 95.35–95.76	90.89 ± 0.11 90.60–91.18
	10	93.57 ± 0.08 93.41–93.72	88.38 ± 0.10 88.19–88.58	96.31 ± 0.08 96.11–96.52	90.70 ± 0.11 90.41–91.99
Speed (rpm)	1000	90.06 ± 0.04 89.99–90.13	85.75 ± 0.04 85.66–85.83	91.25 ± 0.04 91.14–91.36	86.18 ± 0.06 86.02–86.34
	1600	96.32 ± 0.04 96.25–96.37	91.18 ± 0.04 91.09–91.27	96.85 ± 0.04 96.73–96.96	91.44 ± 0.06 91.28–91.60
	2000	–	–	101.09 ± 0.04 100.97–101.20	95.46 ± 0.06 95.30–95.62
Gear	2	93.14 ± 0.04 93.07–93.21	88.57 ± 0.04 88.48–88.66	–	–
	3	93.24 ± 0.04 93.17–93.31	88.35 ± 0.04 88.27–88.44	–	–

Different levels of engine speed regardless of fuel type and gear and 3- Different gears regardless of fuel type and engine speed, in situations of moving and stagnation in both the position of the bystander and the driver.

Conclusion

In this study, the effects of ten different types of fuel blends and engine rotational speeds on noise pollution emitted by tractor engines were studied considering the noise pollution in the driver and the bystander's positions. Moreover, the results analyzed by SPSS software revealed that in the driver and bystander's positions, the effects of fuel type was influential on noise pollution with confidence of 95 and 99%, respectively. However, the engine rotational speed and the interaction between fuel type and engine rotational speed were effective with confidence of 99% in both positions. Comparing the means of noise pollution emitted by the stationary MF285 tractor in the driver and bystander's positions demonstrated that the noise pollution rose with the increase of the engine rotational speed. The differences between the various levels of the rotational speed of the engine were significant in the noise pollution. However, when the tractor was moving and in the driver's position, the interaction between fuel type and gears as well as the interaction between engine rotational speed and gears were insignificant. That was why their triple interactions were influential on noise pollution with confidence of 95%, whereas in the bystander's position, the effects of gears and its double and triple interactions with other factors were negligible. Above all, it was concluded that in both the driver and bystander's positions, $B_{25}E_4D_{71}$ fuel, made of 25% of biodiesel and 4% of bioethanol, was identified as the blend with producing the least noise pollution.

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