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Assessment of Tractor Noise Level during Tillage Operation with Rotavator

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Abstract:

Tractor noise consists of engine noise, exhaust, intake fan and mechanical noise created by combustion, gears, cams, bearings and pumps, etc. Its noise spectra cover the entire audible range from 20 Hz to 20 kHz. The severity associated with noisy tractor may be annoying to varying degrees, lack of concentration, fatigue, rhythm disturbance and damage to hearing. In this paper noise of tractor (MF 1035 DI) at operator's ear level and for bystander's position was measured during no load (NL) and tillage operation with rotavator at different engine speeds. The results showed that noise level during tillage operation was higher than during NL condition. It is found that the effect of engine speed was significant at 5 percent level of significance. it is observed that noise at a tractor operator's ear level during tillage operation with rotavator was higher than the permissible level (85 dB (A)) which was given by Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH).

Key words: Noise; Tractor Noise; Agricultural workers; Tractor operator's health; noise measurements

Introduction

The use of machines in mechanization processes of agricultural production has brought about the factors such as noise, vibration, gas, etc., which affect the working environment of users and inspectors of those machines. Tractors have become the main source of power in Indian farm. Anon., (2012) estimated that nearly 4.3 million tractors were in operation, and 1 in 20 rural households owned a tractor in 2011. India is the largest producer of tractors in the world, manufacturing more than 2.6 lakhs tractors per year. There has been steady growth in tractor production right from I96I -1962, when the production was mere 880 tractors per year to 1999-2000, when it has reached the record of 2.67 lakhs, the highest in the world (Anon., 2014). The tractor utilization was 677.47 hours, annually for different agricultural operations and 140.70 for non-agricultural work (Ghuge 2008). Noise is an unwanted sound which is a vibrational phenomenon transmitted through solid, liquid or gas medium. This interpretation implies s value judgment of the sound, which in turn generally implies the response of human beings to the environment. It is one of the most important environmental factors, which affects the workers' health and efficiency. Exposure to continuous noise of 85-90 dB(A), particularly over a lifetime in industrial settings, can lead to a progressive loss of hearing, with an increase in the threshold of hearing sensitivity (Stansfeld S.A. and M.P. Matheson (2003). Since all the tractors, manufactured in India are operated by diesel engines, they are very much affected by their high intensity of vibration and higher sound level. This has lead to a serious increase during the last few decades of the exposure of farm worker to vibration and noise. Recently noise generated by tractors has received a great deal of attention, not

only from the operator but from the manufacturer as well. The increased emphasis on operator's safety and comfort has created a demand for stricter control of these aspects. The severity associated with noisy tractor may be annoying to varying degrees, lack of concentration, fatigue, rhythm disturbance and damage to hearing. Approximate rules have been laid down, which specify the safe noise level for no permanent hearing loss, usually for an exposure of 8 h per day for a working lifetime (Aybek et al. (2010)). If tractors produce noise more than 85 dB(A) for 8 hours exposure (based on the (NIOSH, 1998) noise exposure recommendation) it will harmful both drivers and bystanders. Noise can increase the overall workload of operators during a specific task and can affect the performance. As a result, noise affects workers' health directly and indirectly (Jaliliantabar *et.al.* (2013)). Keeping all these points in mind, field experiments were performed to assess the noise level of the tractor while used in different operations.

Material and Methods

Evaluation of noise level for Tractors Operators and Bystanders

Field experiments were carried out at the SHIATS farm, Allahabad; UP to evaluate the noise level for Tractors operators and bystanders during tillage with rotavator according to SAE noise measurement procedure during selected farm operation at different engine speed. The tractor used in this study was 6 years old Massey-Ferguson (MF 1035 DI). A precision sound level meter with a condenser microphone type 4165 was used with a frequency range of 20 Hz to 20 KHz.

Area for Noise Measurement at Operator's Ear Level

The tractor will be situated on the straight test path having a length of 20 m. The speed of the tractor should be stabilized for an adequate time. The noise meter will be mounted 1.5 m above

the ground surface and 100 mm away from the operator right ear. Fig.1 shows the dimensions of the area in which the tractor noise will be measured. The minimum values of R, L and W will be at least 20, 15 and 2 m respectively.

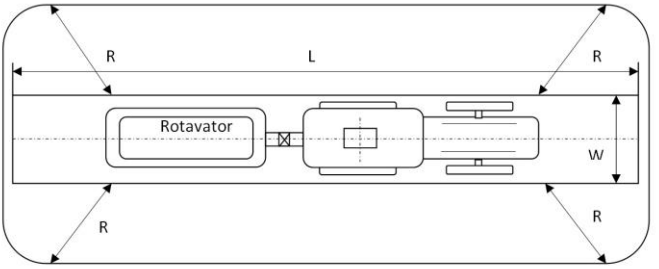

Figure 1: Noise Measurement Area for Operator's Ear Level

Area of Noise Measurement for Bystander's Position

The test specifications will be similar to the specification mentioned for the operator's ear level except that the noise meter will be mounted 7.5 m away from the center line of tractor path and 1.2 m above the ground surface. Fig.2 shows the dimensions of the area in which the tractor noise will be measured. The minimum values of R, L and W will be at least 20, 15 and 2 m respectively. Table 3.3 shows the detail of experimental design during using rotavator.

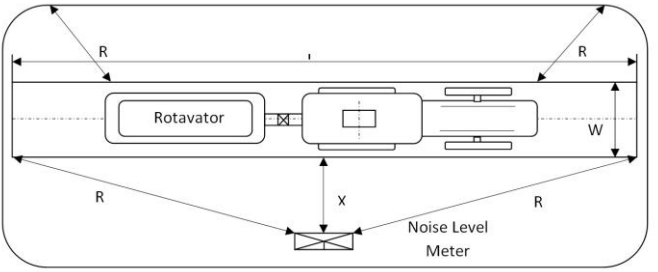

Figure 2: Noise Measurement Area for Bystander's Position

Results and Discussion

The experiment was conducted while Massey-Ferguson (MF 1035 ID) tractor attached with rotavator at no load (NL) in the field at different engine speed then during tillage operation at different engine speeds (Fig.3). Fig.4 shows the mean noise level at operator's ear level produced by the tractor during no load (NL) and tillage operation at different engine speed. It is clear from Figure 4.7 that the noise level produced by the tractor at the operator's ear level during no Load and during tillage operation increased as engine speed increased. The maximum of mean noise level during NL was 87.7 dB(A) at 2000 rpm engine speed. The minimum of mean noise level during NL was 82.4 dB(A) at 1000 rpm engine speed. The minimum noise level during tillage operation with rotavator (with load) at the operator's ear level was 87.4 dB(A) at 1000 rpm engine speed. The maximum noise level during tillage operation with rotavator (with load) at the operator's ear level was 96.82 dB(A) at 2000 rpm engine speed.

The effect of engine speed on the tractor noise level at the operator's ear level during tillage with rotavator was evaluated statistically and presented in Table 2.

Table 2 shows the mean values of noise level produced by the tractor at the operator's ear level during tillage operation with rotavator. The effects of load and engine speed and the interaction between them were significant at the 5 percent level of significance. From this study it was observed the tractor noise at the operator's ear level during tillage operation with rotavator (with load) higher than no load condition for all engine speed. This due to the fact that the engine had to produce more horsepower to overcome the load increment and this increased the noise. Also, it is observed that the tractor noise at the operator's ear level increased as the engine speed increased for both no load and with load conditions (tillage operation). This was due to the fact that engine produces more

horsepower when engine speed increased and this leads to increase the noise which produced by tractor engine as well as the rotavator. From Table 2 it is observed that noise at a tractor operator's ear level during tillage operation with rotavator was higher than the permissible level (85 dB (A)) which was given by Occupational Safety and Health Administration (OSHA) and National Institute for Occupational Safety and Health (NIOSH) and International Organization for Standardization (ISO) .

Fig.5 shows the mean noise level at bystander's position produced by the tractor during no load (NL) and tillage operation at different engine speed. It is clear from Figure 4.8 that the noise level produced by the tractor at bystander's position level during no Load and during tillage operation increased as engine speed increased. The maximum of mean noise level during NL condition was **74**.8 dB(A) at 2000 rpm engine speed. The minimum noise level during NL condition at bystander's position was 66.4 dB(A) at 1000 rpm engine speed. The minimum of mean noise level during tillage operation with rotavator (with load) was 70.83 dB(A) at 1000 rpm engine speed. The maximum noise level at bystander's position was 77.85 dB(A) at 2000 rpm engine speed. From Figure 4.7 and Figure 4.8 it is found that the noise level at the operator's ear level more than at bystander's position. This due to fact that noise level decreased as the distance increased from the source of noise (tractor). However, These noise levels at bystander's position less than permissible level of 85dB which recommended by occupational safety and health administration (OSHA) and national institute for occupational safety and health (NIOSH).

The effect of engine speed on the tractor noise level at bystander's position during tillage with rotavator was evaluated statistically and presented in Table 3.

Table 3 shows the mean values of noise level produced by the tractor noise at the bystander's position during tillage

operation with rotavator. The effects of load and engine speed on the tractor noise level at bystander's position were significant at 5 percent level of significance. However, the interaction between them was found not significant. From this study it was observed the tractor noise at the bystander's position during tillage operation with rotavator (with load) higher than no load condition for all engine speed. This due to the fact that the engine had to produce more horsepower to overcome the load increment and this increased the noise. Also, it is observed that the tractor noise at the bystander's position increased as the engine speed increased for both no load and with load conditions (tillage operation). This was due to the fact that engine produces more horsepower when engine speed increased and this leads to increase the noise which produced by tractor engine as well as the rotavator.

Conclusions

It may be concluded that The noise produced by tractor at operatotr's ear level during tillage with rotavator is more than the allowable level of 85dB(A) which indicate that the operators were under threat from noise and safety actions are desirable. The tractor drivers should always work with lowest engine speed and the this case, tractor would not produce enough power to do the job. The alternative solutions are either stay on driving for less than 2 hours with tractors without a cabin or open window cabin or the use of the ear protector such as ear plugs and muff and tractor cabins are recommended as means by which the noise exposure could be reduced.

Table 1: Details of Design of the Experiment for Evaluation of Tractor Noise Level during tillage with rotavator

Dependent variables	Independent variable	Levels	Description
Noise Level dB(A)	Engine Speed	3	1000, 1500 and 2000 rpm
	Load	2	No load and with load

Replications 6
Trials 3 x 3 x 2 = 18
Design Factorial Randomized Block Design (FRBD)

Table 2: Tractor Noise Level during using Rotavator at The Operators's Ear Level

Levels of rpm (R)	Noise Level		Mean Noise Level
	At No Load	With Load	
1000 rpm	82.40	87.40	84.90
1500 rpm	85.23	92.33	88.78
2000rpm	87.70	96.82	92.26
Mean Noise Level	**85.11**	**92.18**	
	F-test	**S. Em. (±)**	**C.D. at 5%**
Engine Speed (ES)	S	0.311	0.622
Load (L)	S	0.254	0.508
Interaction (ES x L)	S	0.440	0.880

Table 3: Tractor Noise Level during using Rotavator for Bystander's Position

Levels of rpm (R)	Noise Level		Mean Noise Level
	At No Load	With Load	
1000 rpm	66.40	70.83	68.62
1500 rpm	70.32	74.75	72.53
2000rpm	74.78	77.85	76.32
Mean Noise Level	**70.50**	**74.48**	
	F-test	**S. Em. (±)**	**C.D. at 5%**
Engine Speed (ES)	S	1.103	2.207
Load (L)	S	0.901	1.802
Interaction (ES x L)	NS	1.560	3.121

Figure 3: Noise Level Measurement at Operators's Ear Level during Tillage with Rotavator

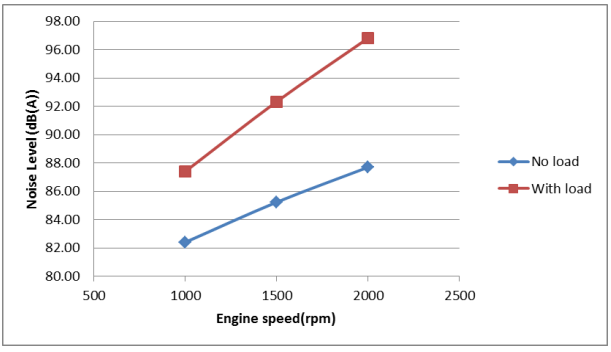

Figure.4: Effect of Engine Speed on Tractor Noise Level While Using Rotavator at Driver's Ear Level

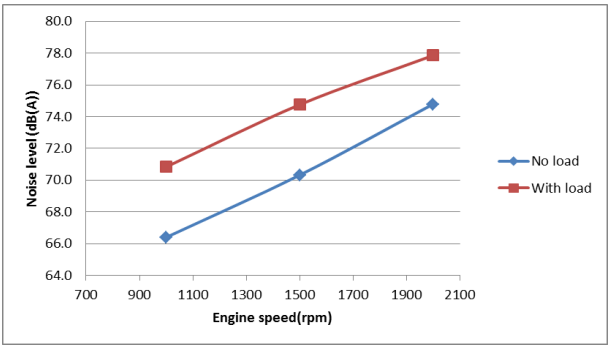

Figure.5: Effect of Engine Speed on Tractor Noise Level While Using Rotavator at Bystander's Position

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