Assessment of tractor noise level during spraying operation while using a tractor mounted aero blast sprayer

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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 the tractor (John Deere (5103)) at the operator's ear level and for bystander position was measured during no load (NL) and spraying operation using an areo blast sprayer at different engine speeds. The results showed that noise level during spraying operation higher than during NL condition. It is found that the effect of engine speed was significant at the 5 percent level of significance. It is observed that noise at a tractor operator's ear level during spraying operation using an areo blast sprayer 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).
Keywords: Noise; Tractor Noise; Agricultural workers; Tractor operator's health; noise measurements, spraying operation

1. 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. It was 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 [1]. There had been steady growth in tractor production right from I96I -1962, when the production was more 880 tractors per year to 1999-2000, when it has reached the record of 2.67 lakhs, the highest in the world [2]**.** The tractor utilization was 677.47 hours, annually for different agricultural operations and 140.70 for non-agricultural work [3]**.** 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 [4]. 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.

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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 [5]. 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 [6]. Noise exposure has also been an indicator of exposure to other factors, both physical and psychosocial, which are also associated with high blood pressure. Unless these other risk factors are controlled, spurious associations between noise and blood pressure may arise. The noise could be a possible contributing factor in the development of arterial hypertension [7]. Laad, (2011) [8] revealed that noise has adverse effect on systolic, diastolic blood pressure and heart rate of the subjects. The occurrence of both hypertension is significantly higher in High Exposure workers compared to Low Exposure and Intermediate Exposure workers [9].The increased Blood pressure among the people (who exposed to noise) may result another type of cardiovascular complications in their part of the life [10]. Furthermore, exposure to high intensity noise in the industry has been linked in some studies to raise levels of noradrenaline and adrenaline [11] and this lead to increase Heart rate, Systolic and diastolic blood pressure.Keeping all these points in mind, field experiments were performed to assess the noise level of the tractor during spraying operation using tractor mounted aero blast sprayer.

2. Material and Methods

2.1 Evaluation of noise level for Tractors Operators and Bystanders

Field experiments were carried out at the SHIATS farm, Allahabad; UP during Winter season 2015 to evaluate the noise level for tractors operators and bystanders during spraying operation using tractor mounted aero blast sprayer at different engine speed (Fig.1) according to SAE noise measurement procedure during. The tractor used in this study was 6 years old John Deere (5103) Tractor. A precision sound level meter with a condenser microphone type 4165 was used with a frequency range of 20 Hz to 20 KHz.



Figure 1: Noise Level Measurement at Operator's Ear Level during Spraying Operation

2.2 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.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.

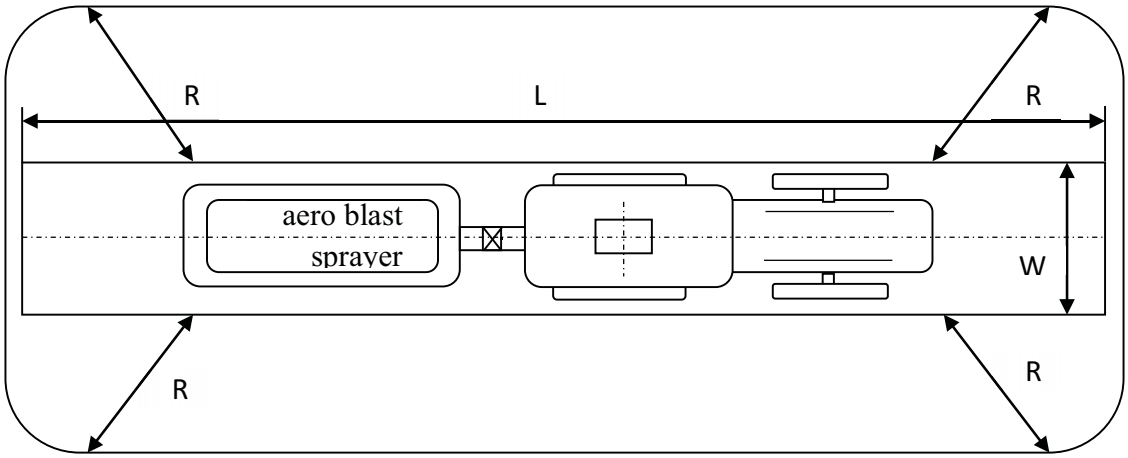


Figure 2: Noise Measurement Area for Operator's Ear Level

2.3 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.3 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.

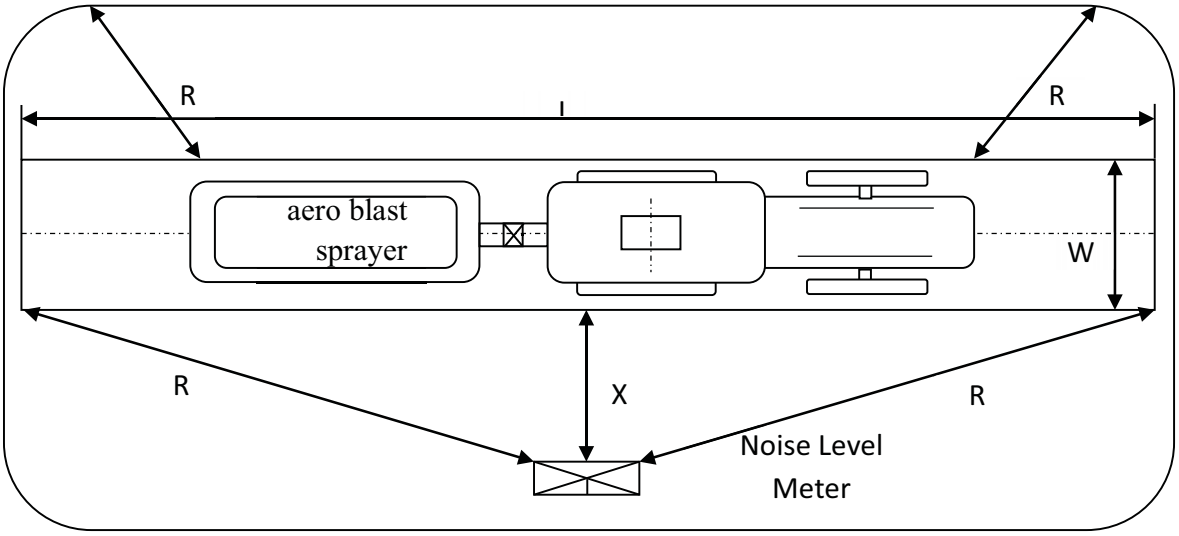


Figure 3: Noise Measurement Area for Bystander's Position

The detail of experimental design during using aero blast sprayer is illustrated in Table 1.

Table 1: Details of Design of the Experiment for Evaluation of Tractor Noise Level during Spraying Operation Using Tractor Mounted Aero Blast Sprayer

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)

3. Results and Discussion

The experiment was conducted while John Deere (5103) tractor attached to aero blast sprayer at no load (NL) then during spraying operation at different engine speeds in the field (Fig.4) shows the mean noise level at operator's ear level produced by the tractor during no load (NL) and spraying operation (with load) at different engine speed. It is clear from Fig.4, that the noise level produced by the tractor at the operator's ear level during no Load and during spraying operation increased as engine speed increased. The maximum of mean noise level during NL was 87.53 dB (A) at 2000 rpm engine speed. The minimum of mean noise level during NL was 83.32 dB(A) at 1000 rpm engine speed. The minimum noise level during spraying operation with aero blast sprayer (with load) at the operator's ear level was 85.92 dB(A)

at 1000 rpm engine speed. The maximum noise level during spraying operation with aero blast sprayer (with load) at the operator's ear level was 93.52 dB(A) at 2000 rpm engine speed. These noise levels were more than the allowable level of 85dB which indicate that the operators were under the threat from noise and safety actions are needed. The use of ear protector such as ear plugs and muff and tractor cabins are recommended as means by which the noise exposure could be minimized.

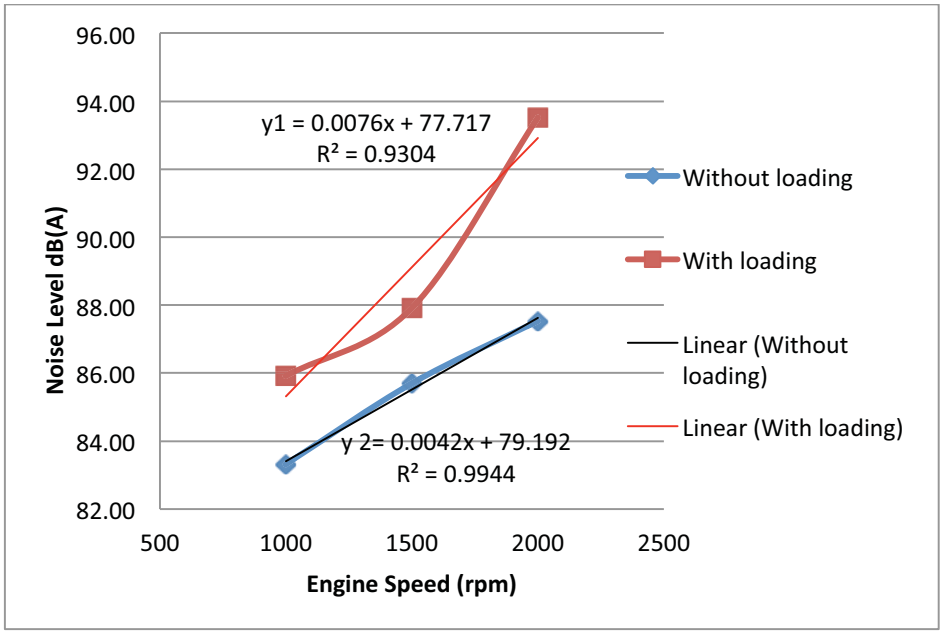


Figure 4: Effect of Engine Speed on Tractor Noise Level during Spraying Operation with an Aero-blast Sprayer at Operator's Ear Level

The effect of engine speed on the tractor noise level at the operator's ear level during sowing operation with a seed drill was evaluated (Table 2). The mean values of noise level produced by the tractor noise at the operator's ear level during spraying operation with aero blast sprayer. The effects of load and engine speed and the interaction between them on the tractor noise level at the operator's ear level 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 spraying operation with aero blast sprayer (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 (spraying 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. From Table 2. It is observed that the noise at a tractor operator's ear level spraying operation with aero blast sprayer was higher than the allowable level (85 dB (A)) which was given by occupational safety and health administration (OSHA, 1983) and national institute for occupational safety and health (NIOSH, 1998)

Table 2: Tractor Noise Level during Spraying Operation with an Aero- blast Sprayer at the Operators's Ear Level

Level of Engine Speed (ES)	Noise Level (dB(A)		Mean Noise Level (dB(A)
	No Load	With Load	
1000 rpm	83.32	85.92	84.62
1500 rpm	85.70	87.92	86.81
2000rpm	87.53	93.52	90.53
Mean Noise Level (dB(A)	**85.52**	**89.12**	
Factors	F-test	S. Em. (±)	C.D. at 5%
Engine Speed (ES)	S	0.287	0.575
Load (L)	S	0.235	0.469
Interaction (ES x L)	S	0.407	0.813

Fig.5 shows the mean noise level at bystander's position produced by the tractor during no load (NL) and spraying operation at different engine speed. It is clear from Fig. 5 that the noise produced by the tractor at bystander's position level during no Load and during spraying operation increased as engine speed increased. The maximum of mean noise level during NL condition was 77.07dB(A) at 2000 rpm engine speed. The minimum noise level during NL condition at bystander's position 68.60 dB(A) at 1000 rpm engine speed. The minimum of mean noise level during spraying operation with aero blast sprayer (with load) was 71.62 dB(A) at 1000 rpm engine speed. The maximum noise level at bystander's position was 79.30 dB(A) at 2000 rpm engine speed. Fig.4 and Fig.5 show that the noise level at the operator's ear level was more than at the bystander's position during spraying operation. This due to fact that the noise level decreased as the distance increased from the source of noise (tractor). However, These noise levels at the bystander's position was less than the 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 sowing operation with a seed drill was evaluated statistically and presented in Table 3. It shows the mean values of noise level produced by the tractor noise at the bystander's position during spraying operation with aero blast sprayer. 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 spraying operation with aero blast sprayer. aero blast sprayer (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 (spraying 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.

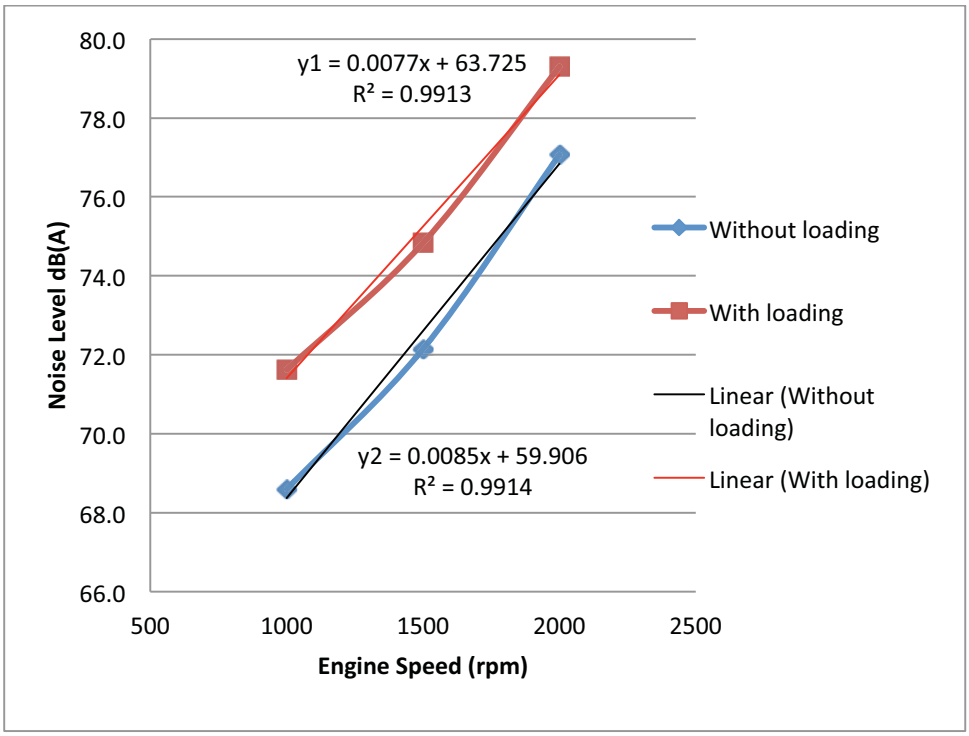


Figure 5: Effect of Engine Speed on Tractor Noise Level during Spraying Operation with an Aero-blast Sprayer at Bystander's Position

Table 3: Tractor Noise Level during Spraying Operation with an Aero-blast Sprayer for Bystander's Position

Level of Engine Speed (ES)	**Noise Level (dB(A)**		**Mean Noise Level (dB(A)**
	No Load	**With Load**	
1000 rpm	68.60	71.62	70.11
1500 rpm	72.15	74.83	73.49
2000rpm	77.07	79.30	78.18
Mean Noise Level	**72.61**	**75.25**	
Factors	F-test	S. Em. (±)	C.D. at 5%
Engine Speed (ES)	S	0.838	1.675
Load (L)	S	0.684	1.368
Interaction (ES x L)	NS	1.185	2.369

4. Conclusions

It may be concluded that The noise produced by tractor at the operator's ear level during Spraying with an aero - blast sprayer 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.

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