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Evaluation of Garden Tools Set and Its Performance Characteristics

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Abstract

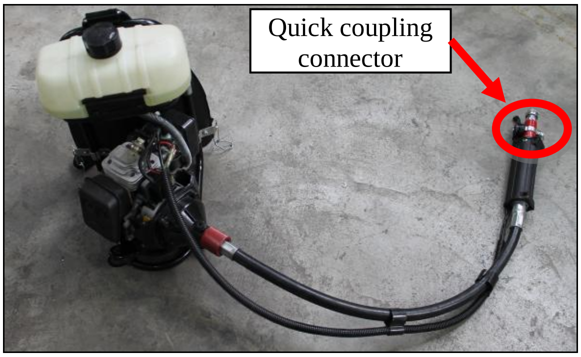
A laboratory and field trial program were undertaken by Automotive Development Centre to determine the performance of a garden tools set consisting of an engine, pruner, trimmer, blower and auxiliaries. The garden tools set was produced to apply three types of tools (pruner, trimmer and blower) operated using one source of prime mover. The tools will be connected to the engine by a "plug and play" quick coupling. The tools are powered by two stroke engine of 27cc capacity. The scopes of this experimental work are to measure the pruner cutting rate, trimmer cutting rate, blower thrust force and garden tools noise test. All tests are done at variable speed of engine. The measured parameter for the pruner cutting rate is the area of branch (mm^2) per cutting time (second) with difference thickness and for the trimmer cutting rate, the parameter is the area of grass space (mm^2) per cutting time (minute) with difference length. Whilst for the blower thrust test, the blower force is measured by the weight machine with the difference distance. The noise test was performed to the garden tools at difference speeds and locations. From this work, the result for each tool is determined. The cutting rate of the trimmer is at the range of 3.22 to 4.55 mm^2/min, whereas for the pruner is from 500 to 1210 mm^2/sec. The thrust measured for the blower is between 30 to 105 kg/ms^2. The noise level generated by the garden tools is at the range of 61 to 94 dB when operating from 1000 to 7000 rpm.

Keyword: *garden tool Sets performance, cutting rate, noise level.*

1. Introduction

The system is designed as garden tools set (pruner, trimmer and blower) plugged with two-stroke, 27 cc engine capacity works as a prime mover. The sets can be connected by "plug and play" quick coupling method.

The pruner is a tool to cut off unwanted branches of tree (or plant) to improve shape of growth within the reach of the operator. The trimmer is a powered handheld device that uses a flexible monofilament line for cutting grass and is suitable for domestic application, namely lawn. The blower is a gardening tool that propels air out of a nozzle to move yard debris such as leaves and dirt alike. Figure 1(a), 1(b), 1(c) and 1(d) show the garden tools set.



(a) The engine as the main prime mover for the tool set.

(b) The engine connected to a long pole pruner.

(c) The engine connected to a trimmer.

(d) The engine connected to a blower.

Figure 1. The garden tools set configuration.

2. Experimental Procedures

In this evaluation work, the system will be tested in order to determine the pruner cutting rate, trimmer cutting rate, blower thrust force and garden tools noise test. All tests are done at variable speed of engine.

The equipments used for this experimental work are digital hand-tachometer, noise level meter and weighing machine. The digital hand-tachometer is a device for measuring rotational speed and velocity of the engine used by focuses a beam of light at a thin/reflection sticker attached to the flywheel. A noise level meter/sound meter is an instrument which measures the sound pressure level, commonly used in noise pollution studies for the quantification of different kinds of noise, especially for industrial and environmental noise. The unit for sound level is decibel (dB) which refers to a logarithmic unit used to describe a ratio which can either be power, sound pressure, voltage or intensity. A weighing machine is a measuring instrument used in the experimental work to determine the force (or mass) exerted on its surface by an object. In this case, the force is exiting from the blower. This unit is used to measure the thrust (=Force/area) produced by the blower under various engine throttling conditions.

For the pruner cutting rate test, a particular test method was taken into account in order to examine the pruner's cutting rate performance of the garden tool. As for the test material for the experiment, two sizes of normal branches of a local fruit tree were considered and tested. The test sample materials were selected to represent as a thick and thin branch of tree. Every test was carried out three times. The operator will cut the specimen that has constant cross section as well as the thickness for every constant speed of the pruner. That means, in one specific running of the tool, all of data are averaged throughout.

Since, trimming rate is inversely proportional with the length of the lawn, the trimmer cutting rate test is done by selected two height of grass, which were one inch and three inch of length for short and long length, respectively. One square meter of each length of the grass was considered to be cleared-off by trimmer tool. It was assumed that the sweep speed of the trimmer was always constant.

The blower thrust test is performed in order to assume the performance of the blower, which the thrust force of effective pressure of the blower was examined. The test was designed to assess the induced air pressure of the air in conjunction of two distances away from blower nozzle tip through the object for 50 cm and 100 cm.

For the garden tools noise test, it is carried out in accordance with the BS EN ISO 11205:2009: Acoustics Noise Emitted by Machinery and Equipment (2009). With regard to the noise standard test procedures, all of the three tools; pruner, trimmer and blower, were evaluated in terms of their Sound Pressure Level (SPL). First of all, the engine was tested for noise emission separately. The engine ran without any tools and then the sound level sensor used to find the noise level. In the second stage, the microphone sensor was carried out in order to sense the sound level of each tool (engine side and tools side) when they were being worked. The test was performed to record the best noise released from the garden tools. As a result, for each tool the microphone sensor were located in four positions of the tools, two points of measurement for engine and two points for the tools. The microphone sensor was installed for 1m of distance from the either the engine or tools. Figure 2 illustrates the positions of the microphone sensor installation for all the configuration of the tool tests.

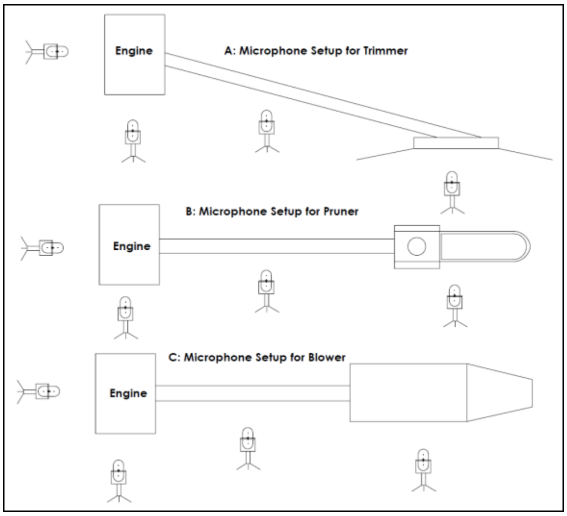


Figure 2. Microphone positions for sound pressure level measurement for each of the garden tool configuration.

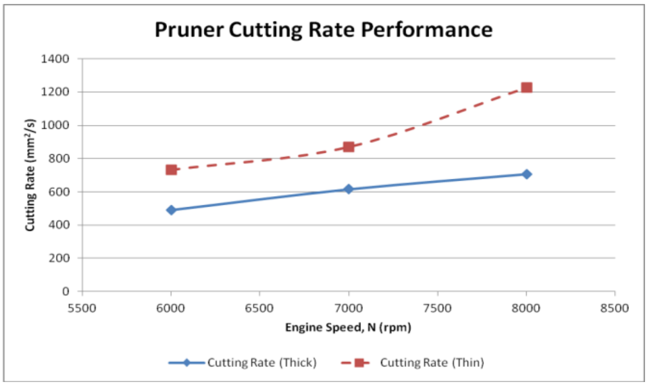
3. Results and discussions

3.1. Pruner Cutting Rate Test

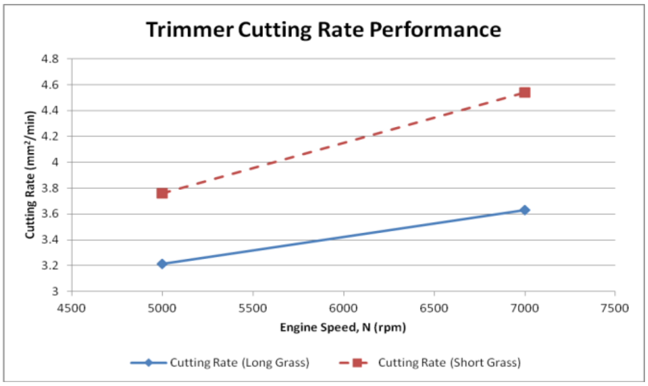
Figure 3(a) shows the result of the pruner cutting rate performance against the engine speed with two difference diameters of tree branch (40 mm and 70 mm). As the engine speed is increased, the greater cutting rate is achieved. For the thin diameter (40 mm), the cutting rate is higher compared to the thick diameter (70 mm). The operator also did not have any problem of handling the pruner to cut the thin diameter of the branch. While the operator cutting the thick branch diameter, some difficulty occurred. This is because the excessive frictional force between the blade and the wood surface in which resulting a load to the pruner and subsequently generate the vibration. The vibration effect has remarkable different between the cutting rate of the pruner when the branch thickness is taken into consideration. The results show that the cutting rate of the pruner is at the range of 500 to 1210 mm^2/s.

3.2. Trimmer Cutting Rate Test

As shown in the Figure 3(b), when the engine speed is increased, the cutting rate will also be proportionately increased. Two heights of grass were investigated for the 25.4 mm height and the 76.2 mm height. As was predicted, the trimmer cutting rate is noted to be higher for the short grass (25.4 mm) compared to the long grass (79.2 mm), for the same area of cutting space (1 m^2). The results show that the cutting rate of the trimmer set is ranges from 3.22 to 4.55 mm^2/min.



(a)Pruner cutting rate



(b) Trimmer cutting rate

Figure 3. Cutting rate performance versus engine speed.

3.3. Blower Thrust Test

Figure 4 illustrates the graph of blower thrust force against engine speed. The distance of 30 cm to 120 cm is considered the most effective distance to blow away unwanted debris using the blower unit. This is the length of between the exit plain of the nozzle to the surface of the ground. According to the results, the long distance (100 cm) of the exit nozzle to the plate of the balance machine, the lower the thrust force compared to the short distance (50 cm). The thrust measured is in between 30 to 105 N for the engine speed of 5000 to 7000 rpm respectively.

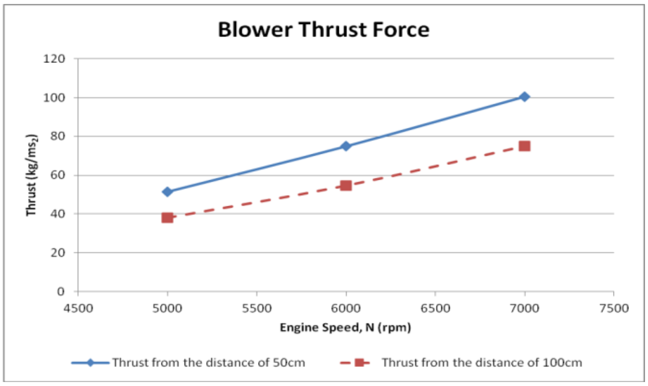


Figure 4. Blower thrust versus engine speed in two different distances.

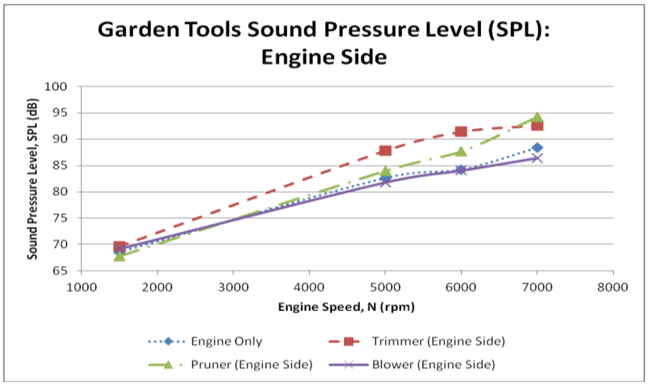
3.4. Garden Tools Noise Test

Figure 2 exhibits the positions of the sound level meter was placed in relation to the tools during the trials. The distance between the sound level meter to the tools is set approximately to 1 m is accordance to BS EN ISO 11205:2009: Acoustics Noise Emitted by Machinery and Equipment.

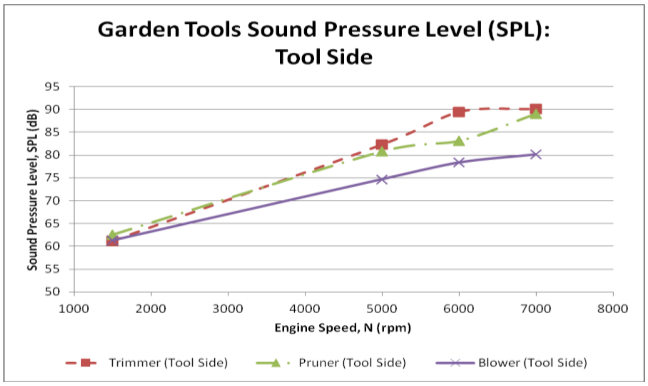
Figure 5 shows the results of the noise level measurement for each garden tool configurations, plotted against the engine's rpm. Figure 5(a) is the results gathered for the engine side and Figure 5(b) is for the tool side. From the evaluation work on the engine and tool sides, it can be observed that the garden tool emitted the least noise is in the blower mode. The pruner and trimmer show the same trend of noise release on the tool side in mid-load. However for higher loads they have depicted a different trend. From 5000 rpm and beyond, the trimmer tool side indicates higher value of sound level than pruner. From the Figure 5(a), the trimmer indicates the highest level of sound level on the engine side compared to the engine only, pruner and blower.

There is a possibility of hearing damage for human if the sound pressure level exceeds more than 85 dB only if the operator performs for long-term exposure, not short-term (refer to standard and health) (Durrant J. D et al 1984 and Bies et al 2003). Consequently, it is recommended to use ear mufflers for the user if the garden tools are used for more than 5000 rpm.

In general for the conventional garden tools, the average sound pressures level released are around 110 dB. Regarding to the evaluation result, the garden tools sound noise level was not exceeded more than 95 dB. It is be worth something to say, the threshold of pain for human is around 130 dB.



(a) Engine side



(b) Tool side

Figure 5. Garden tools sound pressure level.

5. Conclusions

The outcome of the test conducted on the garden tools set are as follows:

i) *Noise level*. The noise level generated by the garden tools is at the range of 61 to 94 dB when operating from 1000 to 7000 rpm. The blower generates the least amount of noise whereas the trimmer produces the most out of the three tools tried. The noise spectrum is still within the given limit of many of the world standards pertaining to engine-powered machinery and equipment (for small engines).

ii) *Cutting rate*. The cutting rate of the trimmer is in between 3.22 to 4.55 mm^2/min, whereas for the pruner is 500 to 1210 mm^2/s, depending on the engine throttling settings. These results are comparable to similar tools produced by top brands where the rates can exceed 5.0 mm^2/min and 1300 mm^2/s respectively.

iii) *Blower thrust*. The thrust measured for the blower mode is between 30 to 105 N for an engine speed of 5000 to 7000 rpm respectively. This is good enough to blow off substantial amount of leaves as by-products of trimming work.

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