International Journal of Agricultural Engineering, Vol. 3 No. 2 (October, 2010) : 343 -347

Research Paper :

Effect of terrain conditions on vibration of power tillers

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Accepted : *September, 2010*

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ABSTRACT

Power tiller is a multi purpose hand tractor designed primarily for rotary tilling and other farm operations. This paper deals with machine vibration of walking and riding type power tillers during stationary mode as well as during rototilling in untilled and tilled fields and in transport mode on farm and bitumen roads. The results indicate that machine vibration increased with increase in engine speed and major excitation of the vibration of the power tiller was the unbalanced inertia force of the engine. In field operation and transport mode the increase in forward speed of operation resulted in increased values of acceleration. The magnitude of handle vibration was more in the untilled field than in the tilled field for both power tillers. The peak acceleration on the handle and underneath the seat was higher on farm road than in bitumen road (tar road). Among the power tillers the vibration induced in walking type power tiller was higher during field operation whereas in transport mode power tiller (8.95 kW) exhibited higher values with same trailer attachment.

Key words : Walking type power tiller, Riding type power tiller, Machine vibration

Among small and medium size category of power sources in agriculture farming, the hand tractor (also known as power tiller) is the most widely used equipment. Excessive vibration and noise level are the important shortcomings in power tiller design. In power tiller system, although the engine is the only source of excitation of vibration, its different moving parts vibrate at different frequencies depending on their own degree of freedom and natural frequencies which contribute to the further vibration of the whole system. This interference of vibration makes the vibration of the whole system rather complex.

Vibration affects human performance. It affects the whole body (Whole body vibration) and it affects parts of it, such as the hands (Hand transmitted vibration). Both whole body and local vibration can cause vibration throughout the body (Rodahl, 1989). Majumder (1994) reported that analysis of power tiller vibration in stationary condition was complex. Acceleration and frequency of vibration changed depending on engine speed and experimental conditions.

The human body reacts to the different kinds of vibration in various ways. The human body is not rigid, and different body parts vibrate differently even if they are under the influence of the same linear vibration (Kroemer *et al.*, 2000). The low frequency vibration transmitted to the power tiller operator may affect vision, reaction time, physiological responses and emotional reactions (Kromer and Grandjean, 2000).

The magnitude of mechanical vibration at different components of the power tiller system under different terrain condition is essential for identifying the source of vibration and thereby providing vibration isolators to increase the safe exposure limit of operators. Thus, the present study measures machine vibration of two power tillers with one as walking type (7.46 kW) and the other as riding type (8.95 kW) during stationary mode as well as during rototilling in untilled and tilled fields and in transport mode on farm and bitumen roads at different forward speeds.

METHODOLOGY

The machine vibration was analysed using the portable multi-analyser system (Bruel and Kjaer Type 3560 C, Denmark). Vibration was measured using the Istron model 751-10 accelerometer. It is a low cost lightweight piezoelectric accelerometer with integral electronics designed specifically for measuring machine vibration in vertical direction. Its frequency response varies from 20 Hz to 20 kHz.

Two power tillers with one as walking type (Power tiller A) and the other as riding type (Power tiller B) were selected for the study, the technical specifications of which are furnished in Table 1.

The power tiller was subjected to proper test conditions before conducting the experiments. It was ensured that it was in full working order with full fuel tank and radiator, without optional front weights, tire ballast and any specialized components. Tyres used for the tests were of standard size and the depth of treads was not less than 70 % of the depth of a new tread. There were no known mechanical defects that would result in