

Abstract

The aim of this study, was to determine the most suitable shaking frequency and amplitude for shake harvesting of lime fruit. A tractor mounted limb shaker receiving its rotating power from the tractor power-take-off shaft was designed and developed for this study. The rotating input power was transmitted to the shaker flywheel through a multiple sheave v-belt drive system, where it was converted to reciprocating motion by a slider-crank mechanism. The resulting vibrating motion was transmitted to tree limb through a telescoping boom and a special clamping device. In order to determine the mechanical and vibrational characteristics of lime fruits, a series of tests were conducted in which, the average pulling force required for detaching ripe and unripe fruits as well as fruit mass and geometric mean diameter were measured. A 3x3 factorial experiment with a completely randomized design with three replications was conducted to investigate the effects of shaking frequency and amplitude on fruit detachment. Three force levels of oscillating frequency (5, 7.5 and 10 Hz) and three levels of shaking amplitude (40, 80 and 120 mm) were investigated. Analysis of variance and mean comparison by Duncan's multiple range test showed that the effects of shaking frequency on fruit detachment was significant, while those of shaking amplitude and its interaction with frequency was not significant. The percent of detached fruits was significantly increased by increasing the shaking frequency. Complete fruit detachment (100%), was obtained by applying the shaking amplitude of 120 mm at 10 Hz frequency, but considerable leaf shattering at this combination of shaking frequency and amplitude was a limiting factor. So, shaking the limbs at 80 mm amplitude and 10 Hz frequency with about 98.5% fruit detachment and negligible leaf shattering was determined to be the most suitable combination. The average static force required for removing ripe fruits was measured to be about 14.2% of that required for removing unripe fruits. The average $F_{s/w}$ ratio (the ratio of tensile force required for removing a fruit to its weight) was measured as 6.9 and 61.8 for ripe and unripe fruits, respectively. The two preceding indices could be considered as a strong possibility for utilizing limb shaker for selective harvesting of ripe fruits in the case of fruit varieties with non-uniform ripening characteristics.