Mechanical Harvesting of Citrus Fruits for Fresh Market with a Trunk Shaker and a Hand-Held Petrol Shaker

A. Torregrosa[1], B. Martín[2], C. Ortiz[1], R. Moreno[3], E. Moltó[3], P. Chueca[3]

[1] Universitat Politècnica València. Dep. Agricultural Engineering. Valencia. Spain. Email: torregro@dmta.upv.es

[2] Universidad Politécnica de Cartagena. Agricultural Engineering Section. Cartagena. Spain

[3] Instituto Valenciano de Investigaciones Agrarias. Montcada. Spain

INTRODUCTION

Citrus in Spain are harvested by hand because they are mainly used for the fresh market. But the continuously decreasing profitability of the crop urges to reduce crop costs, and from these, harvesting is one of the more important.

Researches have been done in the possibilities of mechanical harvesting of oranges, lemons and mandarins, cultivated under the Spanish conditions, trees planted in frames of 6-7 m between rows and 2.5 -4.5 m in the row; the overall dimensions of the trees were 2.5-3 m in height and the trunk cross was 0.35-0.70 m above the ground. The trees were drip irrigated.

MATERIALS AND METHODS

The harvesting equipment was a) an inertial trunk tree shaker that produced displacements of 2.5 cm and a frequency of 10-25 Hz and b) a hand-held petrol-shaker, with a stroke of 6 cm and variable frequency between 10-25 Hz. Trees or branches were shaken one or two times during 3 s each time.

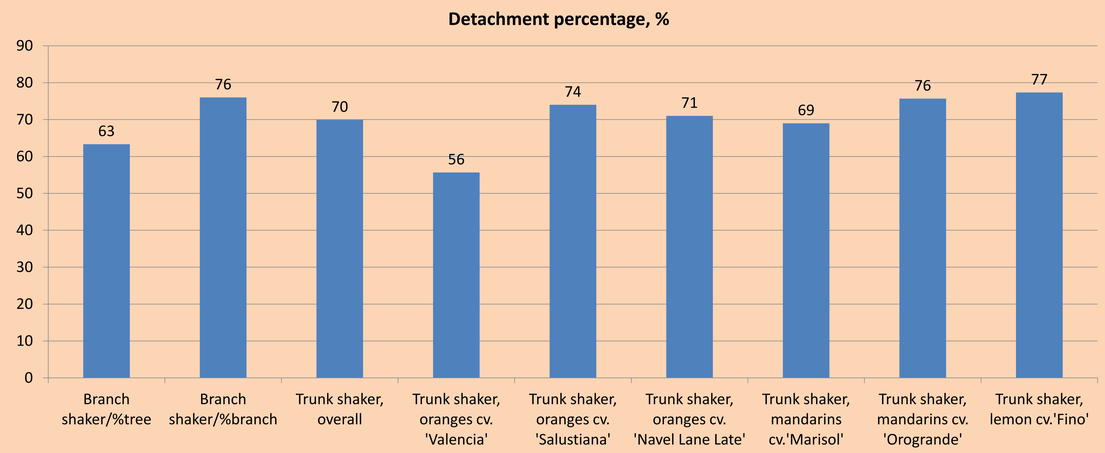
Fruit was collected directly over the ground and over the ground covered with different shock absorber canvases: canvases with and without air-bubbles, film protector directly placed over the ground and elevated canvases hanging from a wheeled structure.

Time required to shake the trees, detachment percentage, defoliation, detachment point of the fruit and fruit damages were evaluated.

ANALYSIS OF RESULTS

Detachment percentage

The overall trunk shaker detachment capacity was 70%. It was observed that tree architecture influenced more in the fruit detachment than fruit traction force. Trees with a favorable branch disposition allowed detachment percentages up to 90%. Hand-held shaker had a high efficiency on the shaken branch (76%), but not when the whole tree was considered (63%), because it was not able to shake the thin and willowing branches. For this reason and for its lower harvesting rate and possible injuries to the operator, this equipment is not recommended.



Defoliation

Defoliation increased with the frequency and with the shaking time, it was more evident in the straight upwards branches. However when 5-6 s of shaking time is not exceeded, defoliation is acceptable.

Fruit detachment point

Detached fruit was classified according to the detachment point: a) with peduncle/stem, b) with calyx, c) without calyx and d) without skin. The main detachment mode was due to the variety and to the maturity stage, but the majority of the fruits were detached with calyx or with peduncle, both types are usable for the fresh market, but the seconds need a complementary operation of stem cutting.

Fruit damages

Citrus damage susceptibility during harvest depended on the variety. Elevated canvases and shock absorber canvases presented similar damage percentages to hand-harvesting and could be used as reception systems in fresh market citrus mechanical harvesting.

ACKNOWLEDGMENTS. This work was partially founded by the Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA) with the projects RTA2009-00118-C02-01 and RTA2009-00118-C02-02, and co-founded by European FEDER founds.