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Research Paper

Mechanical versus manual harvest of *Pinus pinea* cones

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Umbrella pine cone production is an important forest non-wood product in Portugal, especially in the region of Alcácer do Sal, where it plays an important role to the local development. Traditionally umbrella pine cones are manually harvested, increasing production costs and, above all, with very high accident risk to the workers. The development of equipment for mechanical harvesting started in Italy in the 1980's. Studies report different values for harvesting efficiency and tree damage, the latter in terms of immature cones and branches detached. In this study a trunk shaker was used to evaluate mechanical harvesting both in terms of efficiency and tree damage induced by trunk vibration. In comparison to the manual process, time required for mechanised harvesting was about 1/15th of the time. The results revealed a mechanical harvesting efficiency higher than 86% with negligible tree damage. Inter-annual harvest efficiency variability was also observed.

1. Introduction

Umbrella pine (*Pinus pinea* L.) in terms of area is the 6th most important forest tree in Portugal. The Portuguese National Forest Inventory of 2005 reported an estimated area of pure, dominant and young plantations of 130,300 ha, 73% of which located in Southern Portugal, mainly in the Alcácer do Sal region (IFN5, 2010). *P. pinea* stands are frequently of low density and are managed to promote crown growth and thereby fruit production, although denser stands are used for timber production. At present, fruit production has a higher income per area unit than timber (e.g. Correia et al., 2010; Mutke, Gordo, & Gil, 2005a).

Traditionally, umbrella pine cone harvesting is done manually, requiring workers to use a stick to detach the

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