

Influence of umbrella pine (*Pinus pinea* L.) stand type and tree characteristics on cone production

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Abstract Most umbrella pine (*Pinus pinea* L.) stands are managed as agroforestry systems, whose main production is fruit, due to the edible and highly nutritious kernels, and are frequently associated to natural or seeded pastures and grazing. The stands have low density, in order to enhance crown growth and fruit production. Nevertheless, cone production, both with regard to number and weight, varies greatly between stands, trees and years. In this study were selected three agroforestry systems, representative of umbrella pine stands whose main production is fruit, and one stand representative of the timber production system, where fruit is the secondary production. It was

evaluated the variability in cone production as a function of the tree's diameter at breast height and crown diameter and the individual tree's competition status. The results indicate that stands managed in agroforestry systems with lower competition and individuals with larger diameter at breast height and crown diameter tend to produce more and heavier cones per tree. The first two principal components of the principal component analysis explain 84 % of the variance in cone production, trees' dimensions and competition index. Tree competition status has a negative impact on production per tree.

Keywords Bivariate correlation · Competition index · Principal component analysis · Tree dimension

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Introduction

Most Portuguese umbrella pine (*Pinus pinea* L.) stands are located in southern coastal regions, representing about 50 % of the forest area, two thirds with 40–120 treesha⁻¹ (IFN5 2010). The stands are characteristic of agroforestry systems, whose main production is fruit associated with natural or seeded pasture and grazing. These systems are advantageous as they provide diverse products and yields (Jose et al. 2004; Eichhorn et al. 2006; Nerlich et al. 2013), especially in the Mediterranean region, where there are water limitations (Eichhorn et al. 2006) and