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Intensive olive orchards on sloping land: Good water and pest management are essential

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Abstract

There is intensive cultivation of olives on sloping land in Jaen–Granada (Spain), Basilicata (Italy) and Western Crete (Greece). The intensive olive groves here are characterised by a tree density of about 250 trees ha^{-1}, yearly fertilisation and pruning, several chemical sprays for pest control, soil tillage once to thrice per year and irrigation up to 2700 $m^3\,ha^{-1}\,yr^{-1}$. Intensive management results in high yields of 3600–6500 kg ha^{-1} but also higher labour costs of 1154–1590€ $ha^{-1}\,yr^{-1}$, varying per area. The major environmental concerns in this system are related to chemical residues in the fruit, the extinction of useful insects, the depletion of groundwater resources, the pollution of soil and water and the erosion of soil. This paper describes the impact of intensive orchard management on natural resources and gives recommendations for soil and water conservation, reduction of chemicals use and biodiversity enhancement. The specific recommendations for the relevant stakeholders—farmers, technicians, agricultural services and policy makers—are based on the experimental evaluation of different agricultural practices and a socio-economic analysis of local and global production and markets.

Keywords: Drip irrigation; Integrated pest management; Pollution; Socio-economic aspects; Soil and water conservation

1. Introduction

In recent decades, EU rural policy has focused on increasing food production by subsidising farmers and financing scientific research. Higher market prices for olive and olive oil have motivated farmers in the European olive-producing countries (i.e. Spain, Italy and Greece) to intensify their production systems. The intensification of agriculture has raised the question of the long-term sustainability of agro-ecosystems (Lal, 1998; Liebig et al., 2004). Olive productivity and profitability have increased, but some negative consequences on the environment have also been observed (de Graaff and Eppink, 1999). Water scarcity has been identified as a key environmental and economic challenge of the next century (Cech, 2003). On the other hand, irrational fertilisation and irrigation have resulted in degradation of natural environments and depletion of groundwater resources (Gonzalez-Alvarez et al., 2006). Excessive fertilisation may result in surface and groundwater being polluted with hazardous compounds (Androulakis and Loupasaki, 1990, cited in Beaufoy, 2004). Additionally, the tendency to repeat applications of pesticides in order to prevent pest infestations and yield loss (Beaufoy, 2004) jeopardises food safety. Moreover, the intensive tillage and scant plant cover promote soil erosion (Pimentel et al., 2000) and physical, biological and chemical soil degradation. Steeply sloping land without any soil and water conservation measures, such as terraces, is more prone to degradation, leading to loss of soil fertility, decrease of productivity and important on- and off-site effects (Kosmas et al., 1997). Apart from its environmental impact, intensive land management also has higher production costs.

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The main constraints to intensive olive production are analysed in this paper and specific recommendations for good agricultural practices are presented for farmers, technicians and policy makers.

2. Description of the study sites

2.1. General orchard characteristics

Based on the initial classification of olive production systems in Spain, Italy, Greece and Portugal, research on intensive orchard management was focused on three target areas: Granada–Jaen (GJ), Basilicata and Campania regions (IT), and Western Crete (HE). The intensive sloping and mountainous olive production systems (referred to as SMOPS, Stroosnijder et al., this issue) in these areas are referred to as GJ5, IT4 and HE3, respectively (Table 1). They are mainly located in hilly areas with low or moderate (<20%) gradients (Fig. 1). All three areas experience a typical Mediterranean climate: the rainfall, which is the main factor associated with the erosion process (Imeson, 1990), falls mostly during autumn and winter. The annual rainfall fluctuates around 450–700 mm in GJ 630–830 mm in IT and 500–700 mm in HE; average annual temperature is 16.5 °C in GJ, 16.7 °C in IT and 18.3 °C in HE (Metzidakis, 2003). Frost is uncommon, and the minimum temperature rarely drops to levels that affect olive trees. In the past, however, tree damage due to snowfall and very low temperatures has been recorded: for example in 2005 there was severe damage in the north of GJ area.

Table 1
Description of the study areas in Granada–Jaen, Spain (GJ); Basilicata–Salerno, Italy (IT) and Western Crete, Greece (HE)

Area	GJ	IT	HE
Annual average temperature (°C)	16.5	16.7	18.3
Annual precipitation (mm)	450–700	630–830	500–700
People employed in agriculture	272,200	68,183	18,135
Total area (ha)	740,000	72,700	65,295

Fig. 1. Intensive olive plantation on a sloping land in Crete.

2.2. Biophysical characteristics

Intensive plantations have a high density of productive trees with yields significantly higher than organic or traditional orchards. Tree density is usually around 250 trees ha^{-1} in the three areas (Table 2). The main varieties are 'Picual' in GJ5, 'Majatica di Ferrandina' in IT4 and 'Koroneiki' in HE3. In 97% of the surveyed plantations, the tree canopy is maintained between 5 and 8 m in height by intensive pruning. The pruning aims to balance shoot growth and fruit production and facilitate agricultural practices, especially harvesting.

On most of the intensive farms, irrigation is by means of local drip irrigation networks. Water volumes of up to 1500 m^3 ha^{-1} in Italy and Spain and up to 2700 m^3 ha^{-1} in Greece are usually applied, mainly during summer (CIFA-DGIFAP Granada, 2005; Favia et al., 2005; Metzidakis et al., 2005a). Tree nutrition is based on mineral fertilisation that is applied annually in amounts between 600 and 850 kg ha^{-1} yr^{-1}. Fertilisers are based on nitrogen and potassium and include smaller amounts of phosphorus, magnesium and boron. The application of compost for soil enrichment is not a common practice.

Pest and disease control is implemented through chemical sprays. The most serious threats are olive fly (*Bactrocera oleae* Gmelin), olive moth (*Prays oleae* Bern) and peacock spot (*Cycloconium oleaginym* Cast). The olive fly is particularly serious in irrigated orchards, where the high relative humidity is favourable for its biology and the large olive fruits are attractive for oviposition. During years of high pest populations, serious quality degradation and economic damage have been recorded when control measures have been inadequate or lacking.

To date, organophosphate (OP) pesticides have been the main elements for pest control. As they are applied in response to population monitoring through traps, the

Table 2
Orchard characteristics of intensive sloping and mountainous olive production systems in Granada–Jaen, Spain (GJ5); Basilicata–Salerno, Italy (IT4) and Western Crete, Greece (HE3)

Area	GJ5	IT4	HE3
Intensive olive groves (ha)	86,000	15,000	30,227
Intensive olive groves (%)	12	21	46
Slope	Low–Moderate	Low–Moderate	Low–Moderate
Average orchard size (ha)	7	5	6
Tree age (years)	10–30	10–30	10–30
Planting pattern	Regular	Regular	Regular
Planting density (trees ha^{-1})	250	250	250
Main variety	Picual	Majatica di Ferrandina	Koroneiki

Source: Xiloyannis et al. (Eds.) (2004) and Fleskens (2005).