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Evaluation of soil and weed management systems in oliveyards

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Introduction
In Mediterranean countries, the erosion of agricultural soils is a very important problem under dryland conditions. In Spain, more than 40% of dryland suffers a soil loss from 6 to 50 t ha⁻¹ year⁻¹, which is considered as a moderate or high erosion rate. A recent work (Pastor, 1999) showed that soil erosion is higher (80 t ha⁻¹ year⁻¹) in perennial crops (olive, almond or vineyards). Tillage is considered one of the cultural practices that increases erosion, being particularly important in sloping fields. One of the best ways to decrease erosion in oliveyards is to reduce tillage and cover the inter-row soil with a winter grass crop. In order to avoid excessive competition for water with the trees, this green cover must be dry at the start of springtime. We compared the influence of different soil and weed management systems that included cover crops, tillage and herbicide treatments, on the evolution of soil water content, on weed control and on olive and oil production.

Material and Methods
Seven soil management systems were tested in three rainfed adult oliveyards of ‘Empeltre’ variety in Calanda (Teruel, Northeastern Spain) with 15 x 35 m plots and five replications. Soil is a calcareous stony loam. The treatments were established in October 1998. Simazine was applied in a band of 6 m width, centred on the tree row, except in the system 1. On the two inter-rows or “alleys” (4.5 x 35 m) different soil and weed management systems were applied:

1- Traditional tillage: every year, four cultivator passes (15 cm depth) on the full surface including the rows, when necessary.
2- Reduced tillage: cultivations as in system 1, but only on the alleys. Tree rows were treated with simazine (3 kg ha⁻¹) + glyphosate (1.62 kg ha⁻¹).
3- Integrated tillage: Herbicide treatment with simazine (1.5 kg ha⁻¹) to all the surface after one cultivation in March.
4- Non-tillage: Bare soil in all the surface with herbicide treatment as in system 2 in October.
5- Barley cover crop: Hordeum vulgare cv. ‘Nevada’ was sown (200 kg ha⁻¹) in November on the alleys. Glyphosate was applied (1.8 kg ha⁻¹) to kill the cover crop in April. Dry mulch was left on the soil surface until the next sowing time.
6- Ryegrass cover crop: Lolium rigidum cv. ‘Nimera’ was sown (25 kg ha⁻¹). Glyphosate was applied as in system 5 to obtain a dry mulch on the alleys.
7- Modified flora cover: the natural vegetation was let growing and treated with MCPA (1.4 kg ha⁻¹) in April to increase the density of winter grass (Saavedra, 1997).

The soil water content was measured monthly with Bouyoucos gypsum blocks at 30 and 60 cm depth. In each replication, two blocks were placed along the tree rows and two in the alleys. The rainfall registered in the weather station of Calanda was 411, 523 and 276 mm in 1999, 2000 and 2001 respectively. Weed control, evaluated by total percent soil cover from weeds, and the main weed species were recorded (each year) in April, July and November. The olives of the two central trees (of each row) were collected, weighted and the average weight of 1000 olives and the (total) lipid yield were determined. To evaluate profitability, the costs of every system were calculated and samples were taken to know the percent of quality fruits suitable to table consumption and those that should be pressed for oil extraction.
Results and discussion

Soil water content. Soil water infiltration decreased in the following order: cover crop systems (5, 6, 7), integrated tillage (3), reduced tillage (2), conventional tillage (1) and non-tillage (4). Barley cover increased the infiltration significantly.

Weed control and weed species evolution. Systems with residual herbicide applied on the alleys (4, 3) and those with tillage (1, 2) were the most effective in controlling weeds. Grass cover crops were only effective in the seasons when enough mulching was obtained. Some weed flora affinities were observed: Chenopodium album and Amaranthus retroflexus preferred tilled soils, while Convolvulus arvensis, Cynodon dactylon, Chondrilla juncea and Erodium spp. were more abundant in the systems including herbicide use. Chenopodium album and Salsola kali grew well in the grass covers. In system 7, a satisfactory cover of Bromus spp., Hordeum murinum and other winter grass was obtained after three years.

![Figure 1. Olive average productions (kg tree\(^{-1}\)) and standard deviations in different systems and years (1999, 2000, 2001).](image)

Olive production. The higher average yield was obtained with barley cover (129%) and the lower with ryegrass cover (78%), being 100% the yield of conventional tillage (30.6 kg tree\(^{-1}\)). Ryegrass cover was too competitive (Fig. 1). Fruits of lower weight and size were produced in systems were tillage was diminished as it was observed by Castro (1994).

Oil profitability. In the 2001 harvest the highest olive total lipid yield was obtained with the ryegrass cover, but the highest percent of table olives (27.6%), of higher economic value (0.57 € kg\(^{-1}\)) and more unit profitability (24.07 € tree\(^{-1}\)) was obtained with the barley cover.

In conclusion, if the results obtained on the first three years of trial are confirmed, the use of a barley cover crop in these oliveyards is feasible and advisable because it can increase crop yield while protecting the soil from erosion.

References