Conservation Agriculture Techniques in Rainfed Tree Crops and Mediterranean Climate: Implications for Erosion and Runoff Control

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Introduction

In the Mediterranean area land degradation is becoming progressively more important due to deterioration in the quality of land in terms of its capability to support land uses (Salvati and Carlucci, 2013). Soil erosion is one of the main physical processes of land degradation, and in Spain is important in both its economic costs and the environmental negative effects (Durán et al., 2008, 2009).

The Alpujarras is a deep valley region running parallel to and south of the crest of the Sierra Nevada in Mediterranean southeast Spain. Soil erosion in the zone is one of the most damaging effects of human activity today and it is accelerated by their actions, particularly through farming. Great efforts have been made to reduce soil degradation from cropland and to minimize off-site impacts by reducing erosion and surface runoff within fields (Durán et al., 2008, 2009).

Conservation agriculture is a system of agronomic practices that include reduced tillage or no-till, permanent organic soil cover by retaining crop residues, and crop rotations, including cover crops. In this context, cultivating crops in strips running across the slope can reduce the risk of erosion by cutting surface water runoff. In Spain, 18.1% of the land (more than 9 million ha) registers soil losses higher than 50 t ha\(^{-1}\) yr\(^{-1}\), the distribution of these soil erosion rates different, depending on the land use or type of vegetation cover. That is, in woody dryland crops such as vineyards (Vitis vinifera), almond (Prunus amygdalus) and olive trees (Olea europaea), the erosion rates are around 95 t ha\(^{-1}\) yr\(^{-1}\), in herbaceous dryland crops they are about 36 t ha\(^{-1}\) yr\(^{-1}\) and scrubland and pasture, the average value is 21 t ha\(^{-1}\) yr\(^{-1}\) (ICONA, 1991).

The main aim of this study was to analyze the application of conservation agriculture strategies based in different soil-management systems: minimum tillage with plant strips (Hordeum vulgare and Vicia sativa) and minimum tillage without plant covers, and its effects on soil erosion and runoff from hillslope in a vineyard orchard in SE Spain.

Material and Methods

The study was conducted in Lanjarón Granada (SE Spain) at location whose UTM coordinates are N36° 53’ 54.87” W 3° 29’ 37.31” and at elevation of 460 m. The soils are Typical Xerorthent, with loamy texture of 54% sand, 27% silt and 19% clay, containing 1.3% of organic matter, and 0.12% N, with 14.6 mg kg\(^{-1}\) P and 56.7 mg kg\(^{-1}\) available K.

The area selected for the study is the part of the rainfed orchard given entirely with vineyard (Vitis vinifera cv. Tempranillo); the planting grid was 1.5 x 3 m. The erosion plots with twelve plants each were located on a hillslope at 20% incline and 56 m\(^2\) (14 x 4 m) of area. Each erosion plot consisted of a galvanized enclosure, drawer collector, sediment and runoff collectors, which were cleared after each erosive event (Figure 1).

There were three types of erosion plots, with minimum tillage and cover-crop strips of Hordeum vulgare (MTHV) and Vicia sativa (MTVS), and minimum tillage without plant covers (MT), all replicated twice. Two strips of 2 m width were planted between the rows of vineyard, the strips run perpendicular to the slope in order to trap eroded soil and reduce the runoff across the hillslope.
During the monitoring period the soil loss and runoff from plots were collected and measured. For each storm, average intensity (I = (Total rain/total time) (mm h⁻¹)) and maximum intensity at 30 min (Iₙₐ) were calculated. By analysis of variance, the means of different effects of cover-crop strips were compared, and differences between individual means were tested using the LSD test at p < 0.01.

**Results and Discussion**

A total of 13 rainfall events were recorded during the monitoring period ranging from 11.0 to 62.3 mm, and maximum rainfall intensity at 30 min from 1.2 to 11.2 mm h⁻¹, displaying high annual and inter-annual contrasts in quantity and intensity. In this sense, Figure 2 shows the variability of soil erosion and runoff response to soil-management strategies studied. Table 1 presents the results for the analysis of the variance concerning the effect of three soil-management systems on the average soil erosion and runoff, being these values not different significantly among studied strategies. In this sense, according to Ferrero et al. (2002) conventional tillage and cover crops systems for the same area in vineyards produced 2410 and 480 kg ha⁻¹, and runoff 56.5 and 26.4 mm, respectively.

Although in this preliminary stage, the trend in controlling the erosion and runoff was more effectively in the minimum tillage without plant strips. In general, the minimum tillage and the combined techniques in vineyard orchards allowed reducing soil erosion and surface runoff, improving the interception of the rainfall water, and consequently increasing the available water. The reduction of erosion and runoff rates was more than 50% in relation to conventional tillage in the study area. Thus, the application of conservation agriculture techniques is essential for an understanding of productivity of soil undergoing erosion, since sustainable planning can mitigate soil-degradation processes in the overall agricultural marginal areas.

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**References**


