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# Hydrological and erosional impact and farmer's perception on catch crops and weeds in citrus organic farming in Canyoles river watershed, Eastern Spain

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ABSTRACT

It is needed to find the proper management from a biophysical point of view to promote sustainable agriculture. However, it is also necessary that farmers accept new strategies that propose cultural and technical shifts. A survey of the farmerś perception, and an assessment of the biophysical impact of catch crops (CC) and weeds (W) on soil organic matter, bulk density, infiltration capacity, runoff initiation, runoff discharge and soil detachment at the pedon scale were carried out. The field measurements in the Alcoleja experimental station demonstrated that organic matter and bulk density after 10 years of *Vicia sativa* L. and *Avena sativa* L. catch crops and weeds managed plots are similar. Both CC and W plots enhanced high infiltration rates under single ring ponding conditions, the runoff discharge was delayed and decreased; and soil erosion rates were lower in comparison to soil erosion rates measured in chemically managed farms. Soil quality was high for both management strategies and soil erosion rates much sustainable due to the live mulch that catch crops and weeds developed. However, an assessment of the farmerś perception in the Cànyoles river watershed citrus production area in Eastern Spain demonstrated that the farmer's community did not accept the use of catch crops or weeds. The survey proved that the farmers would accept the use of CC and W if subsidies were paid. The farmers claimed for the payment of the seeds and sowing expenses plus a 57 € $ha^{-1}$ for the CC and 75 € $ha^{-1}$ for W on average. The farmers considered the use of CC and W as benefit for the society, but not for them.

## 1. Introduction

Sustainability is a multifaceted concept. It is based on biophysical issues, but also it is a social and economic concern (Chopin et al., 2017; Lavigne et al., 2012). In agricultural lands, the farmerś perception is essential to achieve this mentioned sustainability (Marques et al., 2015; Sastre et al., 2016). To properly survey how sustainable agriculture crops are, it is necessary to find the right management from a biophysical point of view, but it is also necessary that farmers accept new management strategies from a cultural and technical point of view (McCarter and Gavin, 2014). Catch crops (CC) are one of the solutions to mitigate high erosion rates in agricultural lands (De Baets et al., 2011), but little is known about their use in citrus plantations and social and economic acceptance inside the farmer's community. Another option for the farmers to conserve a cover to control soil and water losses is to allow weeds (W) growing (Döring et al., 2005). However, few research is done about whether catch crops or weeds are a better strategy to control soil erosion rates and improve infiltration. This information may be relevant for the farmers as soil erosion rates in citrus plantations are high under conventional management both with herbicides or tillage (Cerdà et al., 2018), in order to find an acceptable strategy that will reduce soil losses to a sustainable rate.

Most of the research carried out on the use of catch crops had the purpose to avoid nitrogen and phosphorus export from fields. Catch crops were used as vegetation strips to act as buffer areas (Askegaard and Eriksen, 2008; Constantin et al., 2010). Catch crops are also often used as a source of nitrogen for other crops. This is why the use of leguminous plants in most of the applied catch crops is widespread.

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**Fig. 1.** Location of the study sites and interview with the farmers. A and B: Localisation of the study area; C: Plot with catch crops; D: Plot with weeds; E and F: Interviews with the farmers.

Organic farmers usually apply catch crops as they improve the nitrogen availability for plants (Thorup-Kristensen et al., 2003), which has been widely accepted by the farmers as a good strategy (Komainda et al., 2016).

Much less attention has been paid to the use of catch crops to improve soil physical, biological and chemical properties. One example can be found in Shennan (1992), who did some research on the impact of catch crops on the quality of vegetable crops. Also, Piotrowska and Wilczewski (2012) researched the soil biochemical improvement due to the use of catch crops; and Zhang et al. (2009) showed how catch crops is able to change water and temperature regimes in soils. Haynes and Francis (1990) insisted upon how mixed crop farming may improve soil properties; and Andrist-Rangel et al. (2007) found that long-term K dynamics are determined by the plants used as catch crops. However, soil erosion control by catch crops has been researched poorly.

Research on soil erosion control focuses on abiotic strategies such as traditional engineering approaches with terraces, geotextiles or heavy infrastructure developments (Durán Zuazo et al., 2011; Tarolli and Sofia, 2016; Rodrigo-Comino et al., 2017). In the last decades, the use of plants as a cover to protect the soil has been expanded due to the low cost and high efficiency (García-Díaz et al., 2017; Kirchhoff et al., 2017). However, there is little information about how catch crops can help to reduce non-sustainable soil erosion rates in agricultural land.

Citrus plantations under Mediterranean climatic conditions result in degraded soils due to the common use of chemical fertilization and the lack of vegetation cover (Cerdà et al., 2017). Moreover, these management strategies trigger high runoff and sediment yield (Rodrigo-Comino et al., 2018a). The widespread soil erosion in citrus orchards around the world resulted in some attempts to find the right management to control soil losses. Lavigne et al. (2012) integrated cover crops to make banana and citrus farming more sustainable. Le Bellec et al. (2012) used cover crops in mandarin orchards and, Liu et al. (2012) applied mulching to reduce soil erosion in a citrus plantation in China. Lü et al. (2012) use hedgerows in the Three Gorges region to improve soil chemical and physical properties and control soil erosion; and Wang et al. (2010) used alley crops to reduce soil and nutrients losses in citrus plantations. Also, in China, other research programs developed soil erosion control strategies on citrus plantations (Liu et al., 2012; Wu et al., 2011). However, in the Mediterranean, where a large production of citrus originates from and high erosion rates occur (Cerdà et al., 2009), little research was carried out on how to control them.

In addition, there is also no information about the farmerś perception about the use of catch crops in citrus plantations. This last issue is particularly important for the chance to implement these measures