Available online at www.sciencedirect.com
SCIENCE DIRECT®
Agricultural water management
ELSEVIER
Agricultural Water Management 82 (2006) 161–176
www.elsevier.com/locate/agwat

Influence of fallowing practices on soil water and precipitation storage efficiency in semiarid Aragon (NE Spain)

D. Moret *, J.L. Arrúe, M.V. López, R. Gracia

Departamento de Edafología, Estación Experimental de Aula Dei, Consejo Superior de Investigaciones Científicas (CSIC), PO Box 202, 50080 Zaragoza, Spain

Accepted 19 July 2005
Available online 12 September 2005

Abstract

The use of long fallowing (16–18 months) for soil water conservation has been questioned in semiarid drylands of Central Aragon. We quantify the soil water loss, soil water storage (SWS) and precipitation storage efficiency (PSE) of long fallow under three management systems (conventional tillage; reduced tillage; no-tillage). The precipitation storage efficiency of long fallow relative to short fallow (5–6 months) was also evaluated. Over 4 experimental years (1999–2002), the soil water balance was calculated from fallow seasonal precipitation and volumetric soil water content (0–70 cm depth). During long fallowing, primary tillage implemented in conventional tillage and reduced tillage plots induced significant soil water losses from the plough layer (0–40 cm depth) for the first 24 h after tillage. However, secondary tillage appeared to have a positive effect on soil water conservation at the end of fallow. The division of long fallow into three sub-periods showed that the early phase (July to November) was the most efficient in terms of soil water storage. Both for the individual fallow phases and the entire fallow period, the precipitation storage efficiency increased when most of the seasonal effective rainfalls ($\geq$10 mm day^{-1}) were received in the last 2 months of each period. Long fallow precipitation storage efficiency was low (11% on average). Neither soil water storage nor precipitation storage efficiency was significantly affected by the tillage system. The average additional soil water at sowing after long fallow compared with short fallow was 20 mm.

Abbreviations: BC, continuous barley cropping; BF, barley-fallow rotation; CT, conventional tillage; *E*, soil water losses (mm); NT, no-tillage; PSE, fallow precipitation storage efficiency (%); RPSE, precipitation storage efficiency of long BF fallow relative to short BC fallow (%); RT, reduced tillage; SWS, soil water storage (mm)

* Corresponding author. Tel.: +34 976 716095; fax: +34 976 716145.
E-mail address: david@eead.csic.es (D. Moret).

0378-3774/$ – see front matter
doi:10.1016/j.agwat.2005.07.019

Accordingly, the average gain in precipitation storage efficiency of long fallow relative to short fallow was only 5.3%. We conclude that long fallowing might not be suitable for enhancing soil water storage in Aragon.

Keywords: Soil water balance; Water conservation; Conservation tillage; Fallow efficiency; Dryland farming

1. Introduction

Water is the limiting factor for grain production in rainfed farming systems of many semiarid dryland regions, where cereal crops are frequently grown under a crop-fallow system (one crop every 2 years). This system generally involves a long fallow period aimed at increasing soil water storage (SWS) and thus the amount of water available to the succeeding crop. With this widespread practice, no crop is grown during the fallow, weeds are controlled by repeated tillage or chemicals and, in general, the soil water recharge occurs during the overwinter fallow period when temperatures and evaporative demand are low and precipitation is high. Contradictory findings on the use of fallow for the purpose of enhancing soil water storage are found in the literature. Bonfil et al. (1999) observed in the south of Israel that the fallow year was beneficial in terms of water storage. Farahani et al. (1998b) questioned this practice in the semiarid Great Plains of the USA because, on average, only 20% of the seasonal fallow precipitation was stored in the soil profile.

Regarding soil management during fallow in semiarid dryland zones, conventional tillage management, with mouldboard ploughing as the primary tillage followed by repeated shallow ploughing, has been found inefficient for soil water conservation (Aase and Siddoway, 1982; Dao, 1993). Fallow conservation tillage systems have been evaluated as an alternative to traditional fallow management (Schillinger, 2001). The agronomic advantages of conservation tillage have also been questioned in terms of soil water storage efficiency during and at the end of the fallow period. Some authors have not observed differences in soil water storage between conventional and conservation tillage (Incerti et al., 1993; Dalrymple et al., 1993; Unger, 1994; Pannkuk et al., 1997; Tanaka and Anderson, 1997); others have reported that no-tillage increases the fallow-precipitation storage efficiency (Schillinger and Bolton, 1993; O'Leary and Connor, 1997; Jones and Popham, 1997). In some regions (e.g., the Great Plains), fallow efficiency remains low even under modern tillage and residue management practices, and consequently the original criticism of fallow still remains (Farahani et al., 1998a).

Long fallowing is still widely practised in the cereal-growing areas of Aragon (Northeast Spain), where the average annual precipitation is less than 400 mm, and rainfall is sporadic and highly variable from year to year during both the fallow period and the growing season. The fallow period lasts for 16–18 months from harvest (June to July) to sowing (November to December) in the following year. Farmers traditionally use mouldboard ploughing plus repeated secondary tillage cultivations for weed control during the long fallow period.

Despite the significance of fallowing for dryland cereal agriculture in Central Aragon and other semiarid areas of the Ebro River valley, there has only been a limited number of field measurements of water stored during the long fallow period and the corresponding