INTRODUCTION

- In Central Aragon (NE Spain), where strong and dry WNW winds (Cierzo) are frequent all year round, the most common cropping system is the cereal-fallow rotation (long fallowing of 16-18 months).
- This cropping system extends over about 430,000 ha (Fig. 1) with a mean annual precipitation less than 400 mm.
- Fallow lands are prone to wind erosion due to insufficient crop residues on the surface and loose, finely divided soils by tillage operations (Photo 1).

Adoption of conservation tillage has been encouraged as a fallow management alternative to prevent wind erosion in Central Aragon.

However, information concerning the dynamics of crop residue cover during fallow is scarce in that region.

The purpose of this work is to show first results on the effects of tillage operations on soil cover by both cereal crop residues and clods during the fallow period.

MATERIALS AND METHODS

- The study was conducted on a long-term tillage experiment at the dryland farm of the EEA-D-CSIC in the Zaragoza province. The soil has a loam texture and mean annual rainfall is 340 mm. Two fallow periods of a barley-fallow rotation, after harvest of the 1998-1999 and 1999-2000 growing seasons, are considered.
- Three tillage systems are compared: conventional tillage (CT) and reduced tillage (RT), with mouldboard ploughing and chiselling as primary tillage operations, respectively, and no-tillage (NT).
- Flat and standing residues were collected after harvest and before and after any soil disturbing practice. Soil cover by flat residues (line-transect method) and silhouette area of standing residues (frontal area) were also estimated.
- Frontal and basal areas of clods (aggregates >38 mm in diameter) produced by tillage were also determined. Soil surface random roughness was measured by using the chain method.

RESULTS

- Average dry mass of barley residues at harvest was 1456 kg ha\(^{-1}\) in 1999 and 855 kg ha\(^{-1}\) in 2000.
- Primary tillage operation has the major influence on residue incorporation (Table 1).

<table>
<thead>
<tr>
<th>Tillage treatment</th>
<th>Primary tillage</th>
<th>Secondary tillage</th>
<th>Seedbed preparation</th>
<th>Sowing</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>96-100</td>
<td>100†</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RT</td>
<td>52-72</td>
<td>38-50</td>
<td>67-73</td>
<td>90-100†</td>
</tr>
<tr>
<td>NT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>56-60</td>
</tr>
</tbody>
</table>

† Initial residue cover is null or negligible (<2%)

After primary tillage, RT and NT plots conserved a residue cover of 10% and 20%, respectively (Fig. 2).

In both years, standing residues, representing 30-50% of total residue mass after harvest, were 100% flattened and buried by mouldboard ploughing and 90-95% by chisel ploughing (Fig. 3).

Clods (4-10 cm diameter) created by tillage were not enough to compensate for the loss of flat residues. In contrast, the frontal surface of these clods was similar and even higher than that provided by the standing residues under NT (Fig. 2).

The combined effect of residue cover and soil surface random roughness (standing residues and clods) on soil loss by wind erosion were estimated by the Soil Loss Ratio, SLR (actual soil loss/maximum soil loss) (Horning et al. 1998. Trans. ASAE. 41, 1061-1065).

The most critical period of fallow for wind erosion occurs under CT after primary tillage (Fig. 4).

The risk of soil loss by wind erosion under RT was similar to that predicted for NT.

CONCLUSIONS

- The traditional tillage practice for fallow management in semiarid Aragon appears to be ineffective for soil protection against wind erosion.
- The lack of residue-disturbing operations makes NT the best strategy for fallow management.
- RT, through a combination of clods by tillage and residues, could be also a viable alternative.

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