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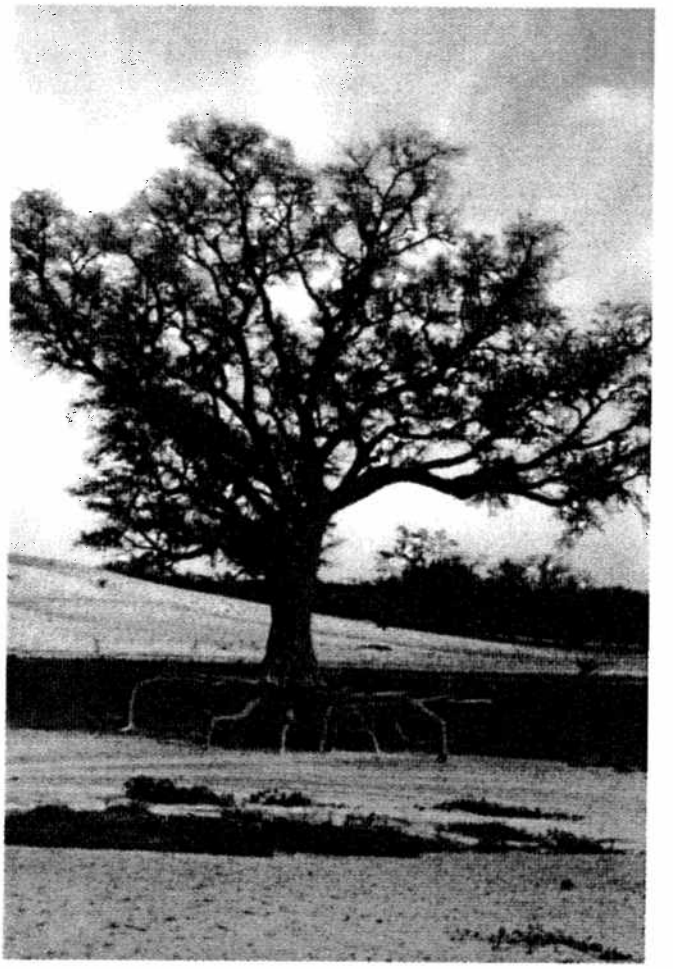

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INDUCED CHANGES IN SOIL PROPERTIES ON ACCOUNT OF INTRODUCTION OF CONSERVATION TILLAGE SYSTEMS: EVALUATION OF THE EFFECTS ON SOIL FERTILITY.

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Two conservation tillage systems were introduced five years ago in a silt loam soil: no tillage (NT) and minimum tillage (MT). Some parameters of soil characteristics after five crop cycles are compared to conventional tillage (CT): organic matter and nitrogen contents during the plant emergence season; bulk density and soil water content were controlled some months before harvesting. The % OM is increasing and % N is decreasing since the beginning of the experiment in all plots including the conventional system. Nevertheless, total amounts (kg/ha) of OM and N in the no tillage plot are significantly higher than in the ploughed plot. In the last 4 months before harvest time, differences in bulk density of the three treatments are reduced to 11.5% and soil water content is 20% higher in NT than in the other treatments. However this condition is not sufficient to assure larger crops, because other factors affect plant production.

1 INTRODUCTION

Tillage systems modify certain soil properties related with soil fertility and water movement throughout soil. In areas where dry farming techniques are

applied, the main objective of soil tillage is to achieve appropriate soil conditions for crop implantation and plant growth. In this communication we evaluate the intensity of changes in some relevant soil properties five years after introducing a leguminous cereal rotation of crops and applying two conservation tillage systems.

2 EXPERIMENTAL DESIGN

A rotation of pea-wheat-wheat-barley was introduced in 1993-94 and has been maintained until present using three different tillage systems: conventional (CT), minimum (MT) and no tillage (NT). Conventional tillage includes plowing and harrowing the soil before sowing. Sowing was on 11-XI-1997 and harvest time on 2-VI-1998. The experiment was carried out in three plots (30* 90 m) located in the north of Barcelona (NE of Spain) on a deep silt loam Calcixerollic Xerochrept (slope 8 to 10%) [1]. During 1993-94 and 1997-98, two soil chemical characteristics were measured in the surface layer (0-15 cm) during the plant emergence season: organic matter and total N content, using an automatic nitrogen and carbon analyzer (C.E. Instruments NA 1500). From January to June 1998 water content in topsoil horizon (0 to 20 cm) was monitored (weekly) using the TDR technique [2] in two fixed points per plot. Two times (January and April) bulk density (5 replicates each) was measured using the excavation method (sample's size is from 200 to 400 cm^3).

3 RESULTS

Soil organic matter concentration (%) in the surface layer increases significantly ($p<0.05$) in all treatments since the beginning of the experience. Although this enrichment is more pronounced in the conservation systems (38-41%) than

in the conventional plot (30%), the increment of % OM is not affected by tillage treatment because no large differences are observed between the plots (table 1).

Year	% O.M.			% N		
	NT	MT	CT	NT	MT	CT
1994	1.47	1.47	1.47	0.11	0.11	0.11
1998	2.07 a	2.03 a	1.92 a	0.075 a	0.078 a	0.061 b

Means for 1998 and for each determination with the same letter are not significantly different ($p<0.05$). NT: no tillage, MT minimum tillage, CT conventional tillage.

Table 1 Mean (n=6) OM and N total soil contents (0-15 cm) on the start of the experience and five years latter.

In contrast, mean total nitrogen is lower ($p<0.05$) than for the initial conditions. Recorded decreases are similar in both NT and MT systems (30%) and higher in the conventional plot (45%) resulting in a statistically different % N when the three treatments are compared in 1998. Results are also evaluated on a mass basis to allow standardization of comparison [3] so is, taking into account that there are changes in bulk density from 1994 to 1998 and between the plots in the sampling time (see latter). Cropping with the no tillage system represents a relative annual accumulation, in relation to the mean of the 93-94 values, of 4493 kg OM ha^{-1}. The no tillage plot has larger mean amounts than both the other treatments. Neither MT nor CT plots show significant differences (fig. 2). Amounts of total nitrogen in the NT system have declined 17% (84 kg N ha^{-1} $year^{-1}$). This decrease is 2.5 significant times lower than in the conventional plot. However, interannual variations in total nitrogen are larger than interannual variations in amounts of organic matter [4].

Bulk density has been evolved in direction to reduce differences between treatments (table 3). Maximum differences observed in January (26%) were

reduced to 11.5% three months later. The time's evolution of soil humidity is similar in three treatments but the water content in no tillage is higher than in the other plots. Available water in the no tillage plot during all the period is the greatest (fig. 4). Just at May's end (20/5/98) the soil moisture was under permanent wilting point during some days in all treatments according to bibliographic values of the FC and PWP [5]. The minimum value of water content in all treatments was recorded at end of April, and CT achieves the minimum value (14.24 mm). These values are obtained after a long dry period (32.6 mm in 75 days). Throughout all monitored period, water content in surface layer of the NT plot (in volume) was also higher, 27%, than in the other treatments.

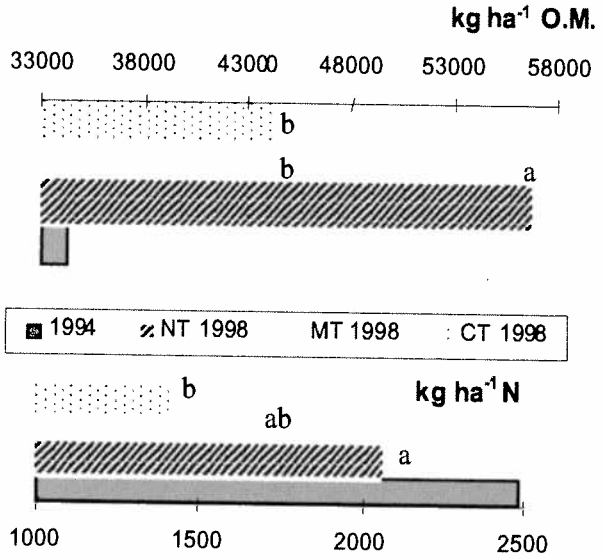
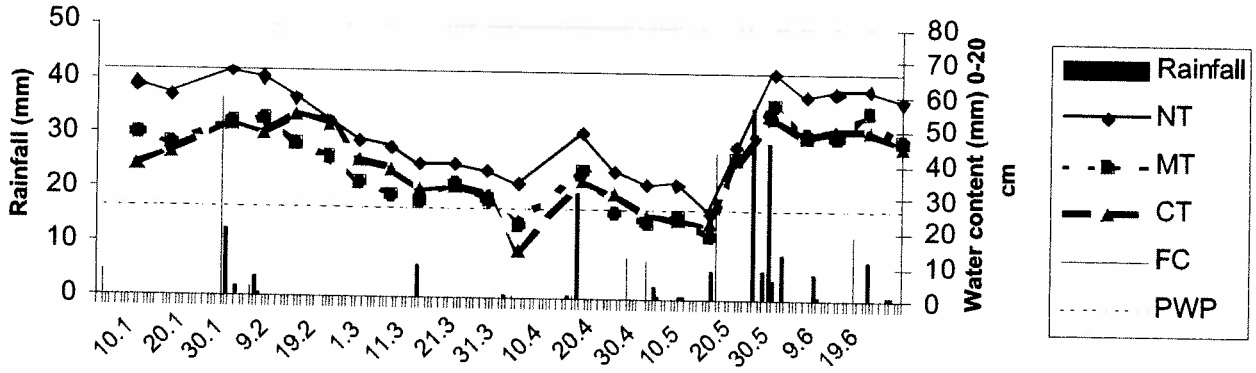


Fig. 2 OM and N amounts in kg ha^{-1}. Means for 1998 with the same letter are not significantly different ($p<0.05$). NT: no tillage, MT minimum tillage, CT conventional tillage

Date	NT	MT	CT
15-1-98	1.834	1.423	1.537
27-4-98	1.795	1.686	1.610

Table 3 Mean (n=5) bulk density values (Mg m^{-3}) in the topsoil layer (0-20 cm).



NT: no tillage, MT minimum tillage, CT conventional tillage.
FC: Field capacity, PWP: permanent wilting point.

Fig. 4 Rainfall and soil water content in the surface soil layer during the 1998controlled period.

In spite of these good soil characteristics, plant production in the NT plot in the year controlled was limited by some problems on sowing time, delayed exceptionally because the wet climatic conditions and losses of seeds by birds.

4 CONCLUSIONS

No tillage is a good system to increase the available water and organic matter in topsoil layer. The soil humidity of NT plot is high throughout all the critical period for plants grow. Nevertheless, all these advantages of NT system have an important limiting factor for plants growing depending on other plant production conditions (specially sowing date).

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