Possibilities and limits of reduced primary tillage in organic farming

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Introduction

In two organically cultivated field trials, located in Germany and Greece, effects of reduced primary tillage systems on root and shoot growth of cereals were investigated. The field trial in Rommersheim near Mainz, Germany, was established in 1994 by the foundation „Stiftung Ökologie und Landbau“. The Agricultural University of Athens established in 1995 a similar experiment in a field trial carried out by The Laboratory of Crop Science, located in Athens, Greece.

Materials and methods

Mouldboard plough, two-layer plough and layer cultivator were used in Germany. Mouldboard plough, rotary hoe and zero tillage were applied in Greece. The field experiment in Germany was performed on a clay loam soil (Calcaric Regosol, FAO) with a 5-year crop rotation (green fallow, winter wheat/catch crop, peas, winter rye/catch crop, spring barley) in a split-plot design. The investigated crop was spring barley. Tillage systems were implemented after cereal harvests only. The field experiment in Greece was performed on a clay loam soil (alluvial, Typic:Argids, soil taxonomy, USA) with a 3-year crop rotation (cereal, green manure, cotton) and a split-plot design. The test crop was winter wheat. The parameters measured every year were: aggregate stability, penetration resistance, root-length density, shoot dry matter, leaf area index, soil surface cover by crops and weeds and crop yield. N, P and K were analyzed in shoot dry matter of crops and weeds. Soil nutrient parameters were: C_t/N_t, N_{min}, P and K contents.

Results and discussion

In Germany higher tillage intensity increased rooting density, nutrient uptake and crop development. Dry matter production of weeds was significantly lower in the ploughed fields compared with those treated with the cultivator. Correspondingly, higher grain yields were positively correlated with tillage intensity. Positive effects of the cultivator on soil properties (e.g. significant higher aggregate stability compared to ploughing) became less significant. In the experiment field of Athens, under minimum tillage (zero tillage and rotary hoe), it was found that root system parameters were significantly higher than those of ploughed plots. Physical, chemical and biological soil properties were also improved compared to those of ploughed soil. Yields were found to be significantly correlated to the root parameters and the soil properties, and this was confirmed by the significant yield increase observed under minimum tillage.

Conclusions

Under conditions of temperate humid climate, sufficient control of weed and optimized nutrient management can only be ensured by turning and mixing the soil. Thus, a general renunciation of ploughing can not be suggested. Under conditions of Mediterranean climate and limited soil water availability, reduced primary tillage becomes more important for the main soil properties and more profitable in the long term. The two-layer plough used in Germany combines the effects of turning and mixing the soil in the upper plough depth, with loosening of the soil in the deeper plough layer, resulting in a good soil structure. Thus, further investigations on the use of the two-layer plough are needed.

References

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