Oilseed rape in minimum tillage systems

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ABSTRACT

Conservation tillage systems have a number of ecological and economic advantages. The soil is not prone to erosion and conservation tillage requires less time and energy compared with conventional tillage Oilseed rape, however, often produces lower yields in conservation tillage compared with conventional systems. In order to study this question under central German soil and climatic conditions, oilseed rape was grown in minimum and conventional tillage systems at two sites on different soil types in central Germany.

In both experiments either on a haplic chernozem (Bernburg-Strenzfeld) or on a stagno-luvic gleysol (Seehausen), oilseed rape produced similar seed yields in most years. The successful implementation of conservation tillage systems is mainly due to a divers crop rotation, high quality of the combine harvest with respect to straw chopping and spreading as well as straw distribution with a comb harrow if necessary. Apart from those prerequisites the genotype vs. tillage system interaction deserves more scientific attention.

INTRODUCTION

Minimum tillage is getting increasingly important in European arable farming systems. The main reasons are soil conservation issues and a strong economic pressure to introduce less expensive tillage systems. Additionally, in some countries minimum tillage system are included in agri-ecological programs and thus farmers receive special payments for implementation. The success of minimum tillage, however, depends on a number of prerequisites, which can be divided into site and husbandry factors.

Conservation tillage systems in Germany are not restricted to specific, separate regions. Apart from the political and economic factors mentioned above, the major environmental reason to introduce such systems is to safe water during the growing season. Recent pools among farmers indicate that within larger areas minimum tillage systems are mainly used on medium loamy soils, whereas heavy clays and sandy soils are less suitable according to farmers experience. Other important motives for the farmers to use minimum tillage systems is cost and labour saving; soil conservation is only important in areas with obvious water erosion risk. Even within suitable areas for minimum tillage systems, the success is very mixed depending on differences in husbandry. Especially oilseed rape seems to be a critical crop in minimum tillage systems (Christen et al. 1999). Compared with other crops our results from long-term field experiments at the University of Halle (Germany) indicate, that crop establishment is in most cases the limiting factor. Unlike cereals and sugar beet, oilseed rape shows in most years a fairly bad establishment in systems without ploughing. During later growth and development rapeseed is often not able to compensate for such a poor establishment (Sieling et al. 1998).

MATERIALS AND METHODS

Field experiments were conducted at two different sites in the states Saxony (Seehausen) and Saxony-Anhalt (Bernburg-Strenzfeld) in central German. This region is characterized by a continental climate. At **Bernburg-Strenzfeld** the annual precipitation depending on the site averages c. 500 mm, and the mean annual temperature was 8.7 °C. The distribution of the annual precipitation shows a clear maximum from June until August. There are, however, periods of severe water shortage in June with considerable influence on the crops. The soil is a loam classified as Haplic Chernozem. Water is the most limiting factor for crop yield in many years. The top ~25 cm of the soil can be described as follows: texture – 21.0 % clay, 67.8 % silt, 11.2 % sand; bulk density – 1.35 g cm^{-3}; field capacity – 32.8 V%; pH – 6.6; total content of C – 2.07 %; total content of N – 0.17 %.

At **Seehausen** in Saxony precipitation averages c. 550 mm, and the long-term mean air temperature 9.2 °C (1966-1996). The soil is a sandy loam classified as Stagno-Luvic Gleysol. It is susceptible to surface sealing and crust formation; the growth of the crops may be adversely affected by waterlogging and drought stress. Water is again in most years the limiting factor for crop yield in many years. The top 30 cm of the soil can be described as follows: texture, 10,0 % clay, 46 %silt, 44,0 % sand; cation exchange capacity, 109 mval kg^{-1}; bulk density, 1.55 g cm^{-3}; field capacity, 28,5 V%;

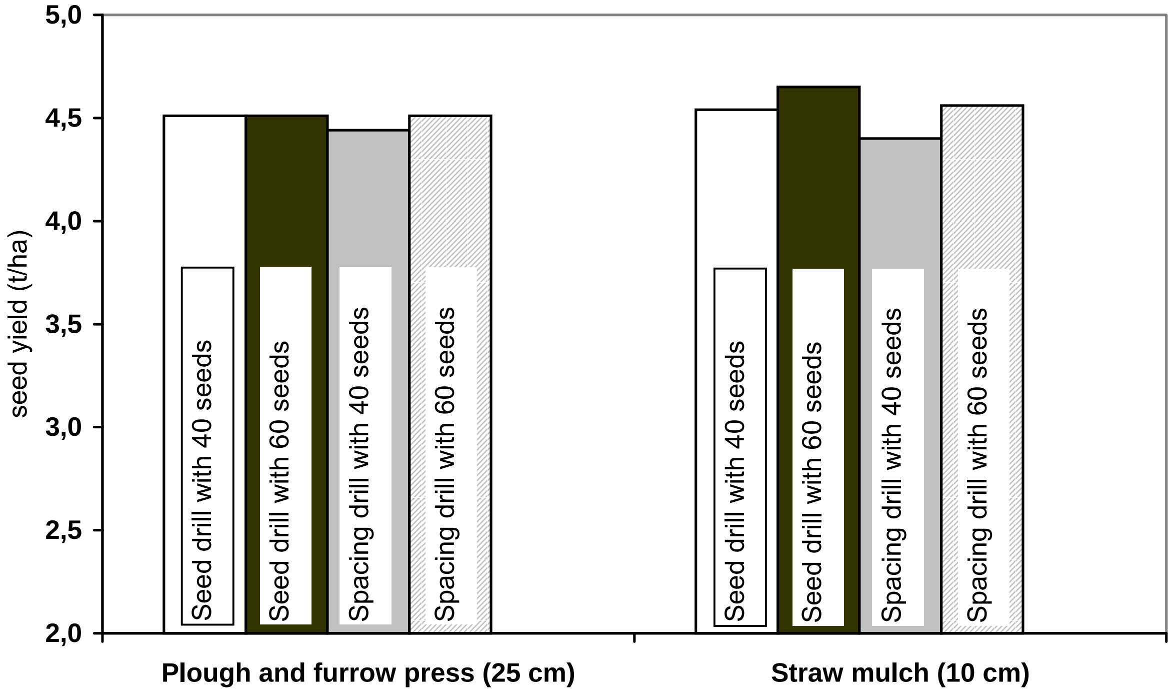
pH (water), 6.7; total content of C 1,02 % total content of N 0,093 %. First harvest year in this trail was 1966.

Oilseed rape was in all experimental years grown after a cereal crop. The husbandry (fertilization, pesticides) was the same in all tillage treatments.

RESULTS AND DISCUSSION

The yield level of oilseed rape at the experimental site at Bernburg-Strenzfeld (Saxony-Anhalt) averaged 4,5 t ha-^{1}. Differences caused by the different tillage, seed implement and seed rate, however, were not statistically significant. There was a tendency, however, that higher seed rates produced a slightly higher seed yield in the straw mulch treatment. The experiment was conducted with to different varieties, one conventional and one hybrid, again, differences between the varieties were not statistically significant and therefore only the results from the hybrid variety are presented.

Figure 1. Seed yield (t ha$^{-1,}$ 91 % dry matter) of oilseed rape in different tillage, seed implement systems and seed rate, Bernburg-Strenzfeld (Saxony-Anhalt) Haplic Chernozem, average of 1999 to 2001



At Seehausen (Saxony) a number of different tillage systems with different depth and a direct drilling system were compared (Tab. 1). The experimental site is characterized by extremely difficult soil conditions for conservation tillage systems because of structural instability and crusts. The differences between the different tillage systems varied from year to year, however, no clear tendency could be identified. One exception, which has to be outlined, is the direct drill treatment in the experimental year 2000. In this crop establishment did not allow for a good stand and caused the sharp yield decrease. Averaged over all four experimental years the different treatments showed no statistically significant differences in seed yield at Seehausen even under the difficult soil conditions.

Table 1. Seed yield (t ha$^{-1,}$ 91 % dry matter)) of oilseed rape in different tillage systems, Seehausen (Saxony) Stagno-Luvic Gleysol, 1991 - 2000

Tillage system	Experimental year				Average	Relative
	1991	1994	1997	2000		
Plough[1] (25 cm)	4,42	4,44	4,17	3,96	4,25	100
Cultivator (25 cm)	4,68	4,43	3,73	4,28	4,25	100
Plough[1] (15 cm)	4,57	4,37	3,70	3,94	4,14	97
Cultivator (15 cm)	4,30	4,36	3,86	4,14	4,16	98
Rotary harrow (10 cm)	4,52	4,18	3,64	4,24	4,14	97
Zero tillage	4,61	4,05	4,61	(15,5)	(3,46)	(81)
LSD t_{α} 0.05	3,8	4,0	2,6	3,3		

[1]Mouldboard plough

The results from two experimental sites in central Germany clearly demonstrate, that oilseed rape can produce respectable seed yields in conservation tillage systems compared with conventional tillage systems. The question remains why practical experience often give opposite results. The reasons, in our opinion, are mainly due to differences in harvest technology, straw management and crop rotation

The successful introduction of minimum tillage systems with oilseed rape, have a number of important prerequisites. First of all, minimum tillage systems require a diverse crop rotation. The more legumes and spring sown crops are included, the easier is the weed and volunteers management. A second indispensable prerequisite is the correct adjustment of the combine harvester in the previous cereal crop. Thus the combine must have excellent straw chopper and chaff spreader qualities given the large amounts of residues and the long cutter bars. This is especially important under climatic conditions, which allow only a short decomposition of crop residues after harvest and after a previous wheat crop. The straw management after harvest is another important issue in conservation tillage systems. Depending on the straw distribution, it might be necessary to use a comb harrow once or twice to improve the spatial straw distribution on the field. Alternatively, if applicable, it is advisable to bale the straw after harvest.

The right choice of variety for conservation tillage systems might also affect the success of such a system. This applies both, to the cereal crop in the previous year as well as the oilseed rape variety. For the previous cereal crop, the important features are harvest date and harvest index (HI), since HI has a great impact on the amount of straw. Additionally the oilseed rape varieties show different adaptations to minimum tillage systems. First experiments at the Institute of Agronomy and Crops Science in Halle-Wittenberg have revealed differences in root growth between different genotypes. Another explanation for genotype vs. tillage system interactions might be differences in susceptibility to allelopathic substances. Bruce and Christen (2001) have recently demonstrated an interaction between different wheat an oilseed rape genotypes based upon a specific release and susceptibility to phytotoxic substances. Those factors in combination might lead to a tillage specific variety recommendation for oilseed rape.

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