

Breeding and testing winter oilseed rape varieties for conservation tillage systems

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Abstract

New varieties are normally developed in very well nursed trials with plough seedbed preparation, but the low cost management of farmers reduces the intensity of tillage. Surveys in Germany show that half of the winter oilseed rape acreage is already planted ploughless, either with deep or shallow cultivation.

The results of variety trials on a heavy clay soil in Northern Germany with three different tillage systems: plough (30 cm), deep conservation tillage (20 cm) and shallow conservation tillage (12 cm) are presented.

Due to dry growing conditions in autumn 2002 the plant development ranged from “poor” under shallow tillage to “good” under plough management. Therefore the yields had a wide range between genotypes and tillage methods. Especially in the shallow tillage plots hybrid varieties showed extra yields of 0.5 t/ha. In autumn 2004 the growing conditions were ideal; the crop development was quite good regardless of tillage system or genotype. The harvest results proofed that the hybrids had a comparable yield within the three tillage systems, the open-pollinated varieties, however, showed a yield decline due to the tillage depth.

In 2004/05 a second location in West Germany and in 2005/06 a third location in South Germany were integrated. The joint data analysis of all three locations for two years show no statistical significant interaction between variety type vs. tillage system, hybrids were better under all three tillage systems. A more detailed analysis of specific cultivar interaction effects demonstrates that a group of hybrid varieties have better adaptation for conservation tillage.

Testing varieties for adaptation to conservation tillage is difficult. There are differences between genotypes developing more vigorous autumn plants and better root systems. There is a trend that hybrids perform better under conservation tillage. More tests need to be done to develop varieties for minimum-tillage or zero-tillage systems in order to reduce the farming costs.

Key words: *Brassica napus*, oilseed rape, tillage systems, seed yield, hybrids

Introduction

New varieties are normally developed in very well nursed trials with plough seedbed preparation, but the low cost management of farmers reduces the intensity of tillage. Surveys in Germany show that already half of the winter oilseed rape (WOSR) acreage is planted ploughless, either with deep or shallow cultivation (Kleffmann AMIS, UFOP, 2004/05).

Low cost farm management systems have continuously reduced the intensity of soil preparation for WOSR. The traditional deep ploughing seed bed preparation is declining in favour of conservation tillage methods. So farmers and breeders are interested to select varieties which are adapted to these cultivation techniques.

Materials and methods

In 2002/03 NPZ-Lembke started to conduct variety tillage trials on one location (Rehhorst) in Northern Germany on a heavy clay soil. In 2004/05 a second location in Western Germany on a loam soil was added (Hovedissen). In 2005/06 a third test location in Southern Germany (Moosburg) on a heavy loam soil was integrated. All three locations represent different climates and growing conditions.

A portfolio of genotypes was tested with three different cultivation systems:

1. Deep ploughing (30 cm)
2. Deep conservation tillage (25 cm)
3. Shallow conservation tillage (15 cm)

The test field at the Rehhorst location has been under conservation tillage for more than 10 years.

The pre-crop varied between winter wheat, winter barley, winter rye and winter triticale. The soil preparation was done in three different strips by local farmers with local equipment (plough, cultivator). The trials were planted in double plots with four replications in a complete split plot design. The number of genotypes resp. cultivars varied each year. The nursing of the trials was integrated in the local management of the farmers. Harvest was done by trial combines.

Results

A. Interaction of soil preparation and WOSR variety type in Northern Germany:

The survey of the yields at the location Rehhorst in Northern Germany (fig. 1) show that the performance of the tillage systems was very different, due to very variable weather conditions in autumn. In autumn 2002 it was very dry, so that ploughing was extra beneficial in comparison to conservation tillage. Extreme yield differences up to 1.5 t/ha have been

measured between plough and shallow tillage. Hybrids in comparison to open-pollinated (OP) varieties showed the highest yields in all tillage systems.

In autumn 2004 the weather has been very smooth and warm, so that the autumn development of the plants was quite even. The yield differences between the tillage systems were only 0.3 t/ha. Again the hybrids showed a superior yield. Shallow and deep conservation tillage performed with hybrids even on the same level with an advantage of 0.2 t/ha for ploughing.

In autumn 2005 the weather has been again very warm and humid. No differences in plant development between the tillage systems in autumn could be recognised. The harvest data indicate a disadvantage of 0.2 t/ha for the shallow tillage method in comparison to deep cultivation and ploughing for OP varieties. The hybrids especially with deep cultivation performed best.

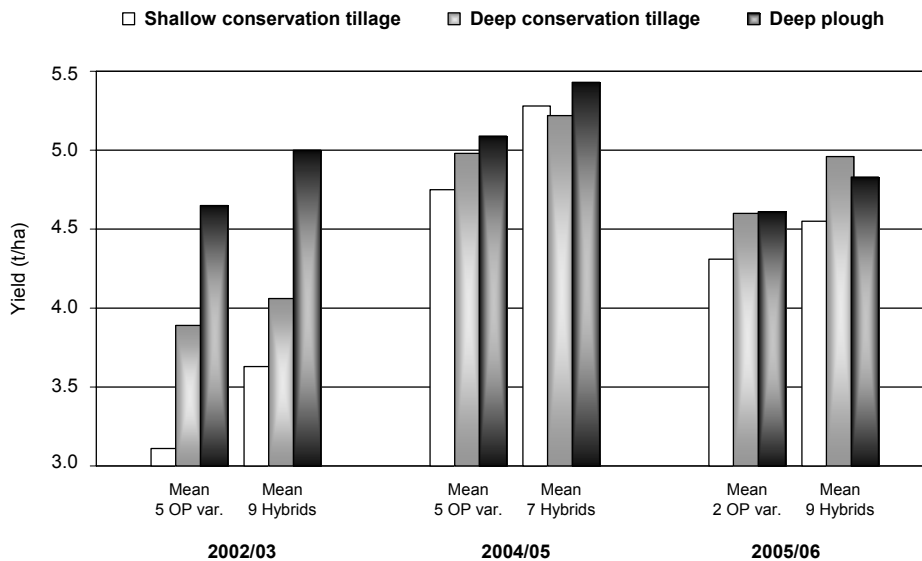


Fig. 1. Seed yield of hybrid and OP varieties grown at 3 different tillage systems in Northern Germany (Rehhorst) during 3 years

This survey of three different results in three years reflects the importance of multi-year trials in order to evaluate suitable results. In 2003 and 2006 the differences between the tillage systems are statistically significant ($p=95\%$).

B. Interaction of soil preparation and WOSR variety type in single trials:

Each year and each location showed an individual result in ranking of genotypes and tillage systems. As an example figure 2 shows the typical performance of eleven varieties in North Germany in 2006 under different tillage methods. Each genotype seems to have a specific character of reaction towards each tillage method. In all six trials statistically significant yield differences between the variety groups of hybrids and OP varieties have been found. Significant differences were also observed between varieties within the group of hybrids and OP varieties.

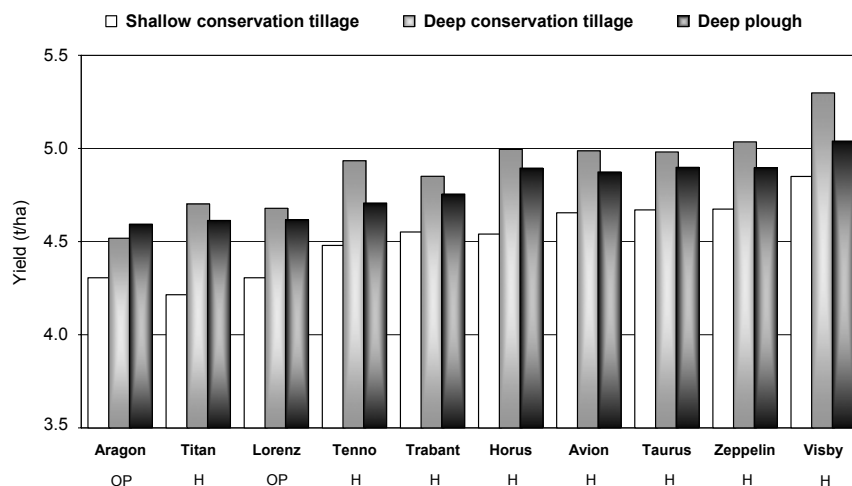


Fig. 2. Seed yield of 11 different genotypes grown at 3 tillage systems in Northern Germany 2005/06

C. Interaction of soil preparation and cultivars in joint results of 2005 and 2006:

For better balancing the results of Northern Germany (Rehorst) in 2005 and 2006 (without 2003), the results of West Germany (Hovedissen) of 2005 and 2006 and the results of South Germany (Moosburg) of 2006 were integrated in the data analysis.

On average the five trials at the three locations and two years (figure 3) showed no statistical significant interaction between variety type vs. tillage system and variety vs. tillage system. Hybrids have had an extra yield of 0.19 t/ha (or 4%) under ploughing conditions in comparison to OP varieties. Under deep resp. shallow conservation tillage conditions the extra yield for hybrids climbed up to 0.27, resp. 0.32 t/ha (or 6 resp. 7%). All hybrids performed best under deep cultivation conditions, OP varieties tended to perform best under ploughing conditions.

Figure 4 demonstrates a more detailed statistical survey for specific cultivar interaction effects by linear contrasts, standard errors and confidence intervals of adaptation for deep conservation tillage vs. ploughing. Thus a ranking of the varieties in their performance has been described. A tendency of varieties which are more or less suitable for conservation tillage can be estimated. In general the group of hybrids tends to have a better adaptation than the group of OP varieties. Within the group of hybrids the varieties Artus, Luxx, Visby und Tenno have shown the best adaptation.

Discussion

Six tillage trials with 29 WOSR genotypes have been conducted during four years at three locations. No significant differences in the cultivar reaction could be proven for five trials in 2005 and 2006. However, positive yield trends for hybrids under conservation tillage can be claimed.

In general it is very difficult to establish good variety trials at different tillage systems, especially if they are carried out in actual farm situations. The quality of the soil preparation and straw management must be good enough for trial plots, but not too good. Depending on the year and weather conditions the yield preference of the tillage systems are changing. The exchange of some varieties in the test portfolio additionally burdens the statistical result by higher standard errors. The trials will be continued to get a more profound data basis.

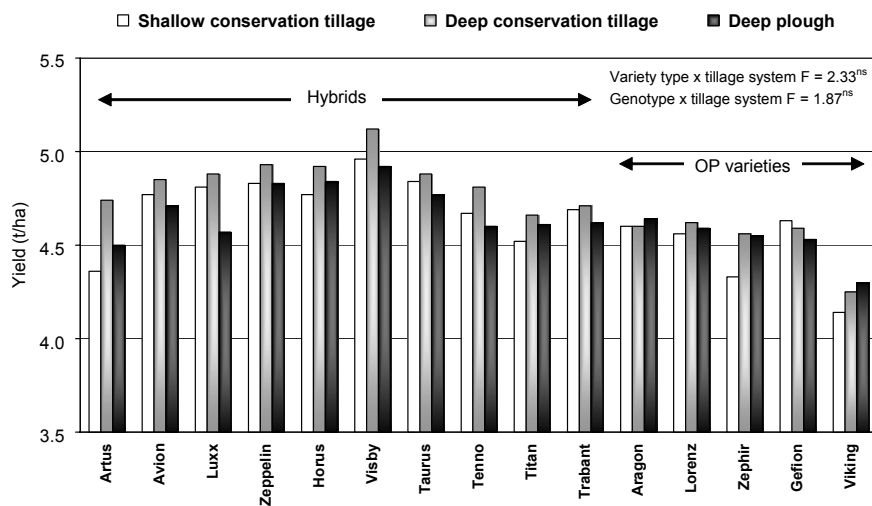


Fig. 3 Seed yields (adjusted) of 11 hybrids and 5 OP varieties grown with 3 different tillage systems in 2-year trials 2005 (2 loc.) and 2006 (3 loc.)

Conclusion

The testing of WOSR varieties for conservation tillage is a long-term project in order to get valid data for farmers and breeders. The results presented show no significant differences for interaction of genotypes with tillage systems, but there is a strong tendency that hybrids have yield advantages at conservation tillage systems in comparison to OP varieties. Certain hybrids like Artus, Luxx, Visby and Tenno have shown very good performance. The data basis is small in regards to a final decision whether it is possible to breed varieties with a specific adaptation for conservation tillage systems.

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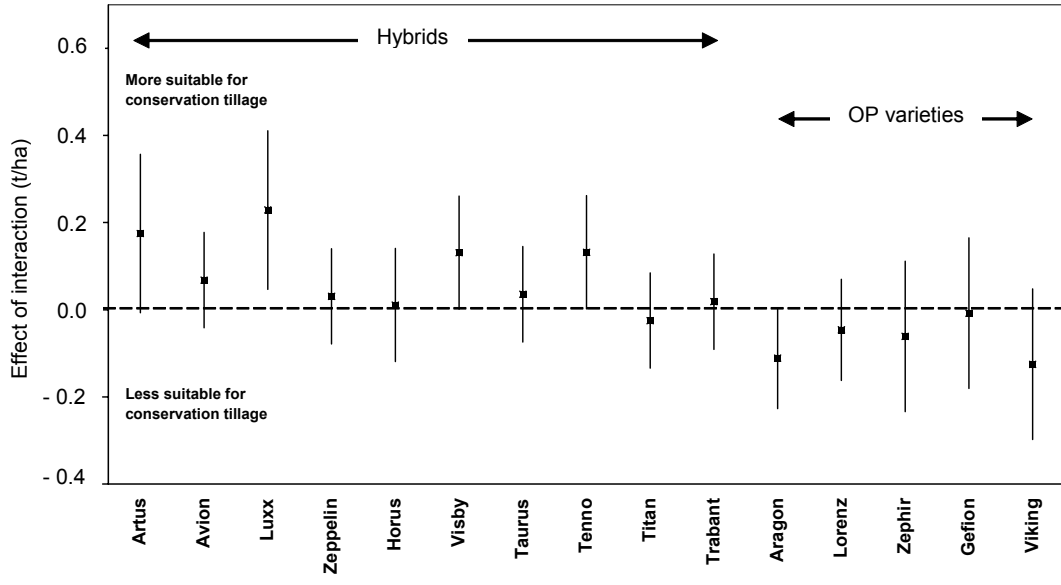


Fig. 4. Variety x deep conservation tillage vs. deep plough interaction effects and their 90% confidence intervals of the trials described in Fig. 3