Effect of sowing date and genotype on the yield, yield formation and root development of winter oilseed rape

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Abstract

Little knowledge exists about the performance of new dwarf and semidwarf winter oilseed rape varieties with respect to development, root growth and seed yield. Therefore we designed a field and a greenhouse experiment comparing different varieties. The field experiment was conducted at the experimental station of the University of Halle, Saxony-Anhalt, Germany with an average precipitation of 450 mm and a fertile black earth soil.

Averaged over the three experimental years, the semidwarf hybrid "Belcanto" showed a 10-20 percent smaller plant length compared with the non-dwarf varieties "Express" and "Talent". This difference was variable between the two experimental years. The rooting depth, however, was only affected in one year and the root morphology before winter was comparable in all three varieties tested following the early sowing date. In the late sowing date, the semidwarf variety showed a greater rooting depth. The apex of the semidwarf variety was located very low above the soil and the soil coverage was high due to the typical canopy of "Belcanto". Unlike in non-dwarf varieties, different sowing dates had only small effects on the seed yield of "Belcanto", which produced higher yields in all three experimental years. Averaged over the experimental years the variety "Belcanto" yielded 5.1 t/ha compared with 4.8 and 4.7 t/ha in the other two varieties. Oil- content of the semi-dwarf variety, however, was lower compared with the other varieties. In an adjacent greenhouse experiment no significant interaction between the genotype and the root development in different bulk density treatments could be measured.

Key words: Oilseed rape, *Brassica napus*, dwarf genotype, seed yield, development, root development, soil bulk density

Introduction

The last decade has seen some major changes in the genotypes of oilseed rape. After the introduction of hybrid varieties, breeders now consider dwarf and semidwarf genotypes to improve yield under specific environmental conditions. The introduction of dwarf varieties has had considerable impact in other crops, however, up to now, only limited information is available on the agronomic consequences as well as the performance and root growth of such genotypes in oilseed rape. Therefore we have looked at the root development in a traditional genotype, compared with a hybrid and a semidwarf hybrid and also compared a number of different genotypes in a greenhouse experiment.

Materials and Methods

Field experiment

The *field experiment* was conducted at the experimental station "Bad Lauchstädt" near Halle in the German state of Saxony-Anhalt. In this paper we report results from the harvest years 2004 and 2005. "Bad Lauchstädt" is located 134 meter above sea level, and has a long term average precipitation of 450 mm per year. The average temperature is 9.0 °C. The soil is a very fertile black earth soil (haplic chernozem) with a large water holding capacity. The texture consists of 20 percent clay and 68 percent silt. The soil has approximately 2 percent soil organic matter in the A-horizon.

The field experiment at "Bad Lauchstädt" had a two factorial design with four replications:

Factor A: Sowing date:
A1 - early sowing – (19. or 20. of August)
A2 - normal sowing - (26. or 27. of August)
A3 - late sowing - (02. or 03. of September)
Factor B: Genotype:
B1 - linebred variety "Express"
B2 - MSL-Hybrid variety "Talent"
B3 - Semidwarf –hybrid variety "Belcanto"

All other husbandry treatments (sowing rate, fertilization, pesticide application) were conducted according to weather conditions as well as incidence and severity of weeds, pests and diseases.

The rooting depth in the field experiment was measured according to Ehlers & Goss (2003) with a minirhizotron. With this method it is possible to observe the root development without any excavating, which will inevitably alter the physiology and / or morphology of the root system. A two meter transparent plastic tube is therefore permanently buried in the plant's root system. In our experiment the plastic tube had a diameter of 64 mm. It is placed in the soil at an angle of 45 °. A special digital

camera was brought to the site and lowered into the tube. Pictures taken through the wall of the tube monitor the growth of new roots over time. By comparing the lengths of roots in digital images taken at different times, it was possible to obtain a quantitative estimate of the oilseed rape root development over time using a sigmodial function ($y = y0+a/(1+e-(^{(x-x0/b)})$).

Glasshouse experiment

In the *greenhouse experiment* a test of the capacity of the different oilseed rape genotypes to penetrate the soil according to Dannowski (1983) was conducted. We use soil in containments of 100 cm³ with an area of 25 cm² at the basis. The soil in the experiment was a sandy loam with 9.6 percent clay, 28 percent silt and 1,3 percent organic matter with a soil compaction of 1.82 g/cm³ under natural conditions. In the experiment we established bulk density (BD) treatments of 1.50; 1.65; 1.75 and 1.80 g/cm³ with ten replications. The water content was adjusted to pF 2.5. Seven rapeseed seeds were placed in each of the containments and covered with sand to minimized evaporation. The light intensity was 420 µmol/m^{-2} for 14 hours during the day at 15 °C and 10 hours darkness during the night with 12 °C at 85 percent relative humidity. The experiment was continued for ten days. After that period the plants were harvested and the emergence, root development, root dry matter, leave number and dry matter was measured.

The following varieties were used in the experiment:

Linebred: "Express" and "Viking"
MSL-Hybrid: "Artus", Talen" and "Baldur"
Semidwarf hybrid: "Lutin"

Results

Field experiment

The emergence winter oilseed rape in the different sowing dates of the field experiment was mainly affected by the following weather pattern in the two experimental years. Within the sowing dates, the differences between the three genotypes were negligible. The greatest effect of the different genotypes on the root length was measured in the late sowing of 2003. In this year the variety "Belcanto" showed a significantly deeper root growth compared with the other two varieties (Fig. 1). This effect did not occur in the early sowing and in any treatment in the second experimental year. We were not able to measure any differences in root development between the varieties in the following spring. The largest root diameter before winter was observed in the variety "Talent". In both experimental years the variety "Talent" produced a heavier root compared with the variety "Express" (data not shown).

Averaged over the two experimental years, the differences in seed yield between the varieties "Express" and "Talent" were only small and not statistically significant. Highest seed yields occurred following the normal sowing date around the 26. to 27. of August. The semidwarf variety "Belcanto" produced the highest yields in all sowing date treatments. On average, the seed yield was almost 0.3 t/ha higher compared with the other two varieties. Oil- content of the semi-dwarf variety, however, was lower compared with the other varieties (Data not shown).

Tab. 1: Effect of sowing date and variety on seed yield [t/ha] of winter oilseed rape. Experimental station "Bad Lauchstädt, Germany, average of the harvest years 2004 and 2005

Variety	Early sowing	Normal sowing	Late sowing	Average
Express	4.70[a]	4.91	4.54[a]	4.72[a]
Talent	4. 70[a]	5.04	4.62[a]	4.79[a]
Belcanto	5. 11[b]	5.10	5.08[b]	5.10[b]

Greenhouse experiment

Averaged over all different genotypes, the largest root growth was observed at a soil compaction between 1.50 and 1.65 g/cm³. Higher degrees of soil compaction decreased root growth to only half the extend. This applied to the number of roots, which penetrated the depth of the compartments as well as the root length. Differences between the genotypes and / or an interaction between the genotypes and the different soil compaction treatments were not statistically significant. Similar effects were observed for the above ground parameter. Soil compaction decreased the number of leaves and the above ground dry matter, however, in accordance with the results for the roots, no differences between the genotypes or an interaction with the soil compaction treatments were statistically significant.

Discussion and Conclusions

Differences in the root development showed a strong interaction with the two experimental years. The better root development in the second experimental year was due to warmer growing conditions in autumn 2004, whereas in the first experimental year cold conditions affected early growth and development. Differences between the varieties only occurred in the year with unfavourable conditions, underlining the importance of variety choice with respect to root development in such years and comparable environments. Similar effects have been described in the literature several times, however, to our knowledge, different winter oilseed rape varieties were only assessed in a very few other experiments. Becka et al. (2004) report no effect of the genotype on root growth, whereas Behrens (2002) report differences due to variety, however, he

compared different genotypes at much later developmental stages and therefore a comparison with our results is fairly limited. The effect of different sowing dates has been reported several times and does not provide any novelty. The interaction with the various genotypes, including a semidwarf hybrid, however, was up to now mainly published in preliminary research reports. Our experiments suggest that semidwarf varieties might have a yield advantage under such difficult conditions, but further experiments with a larger sample of genotypes are needed.

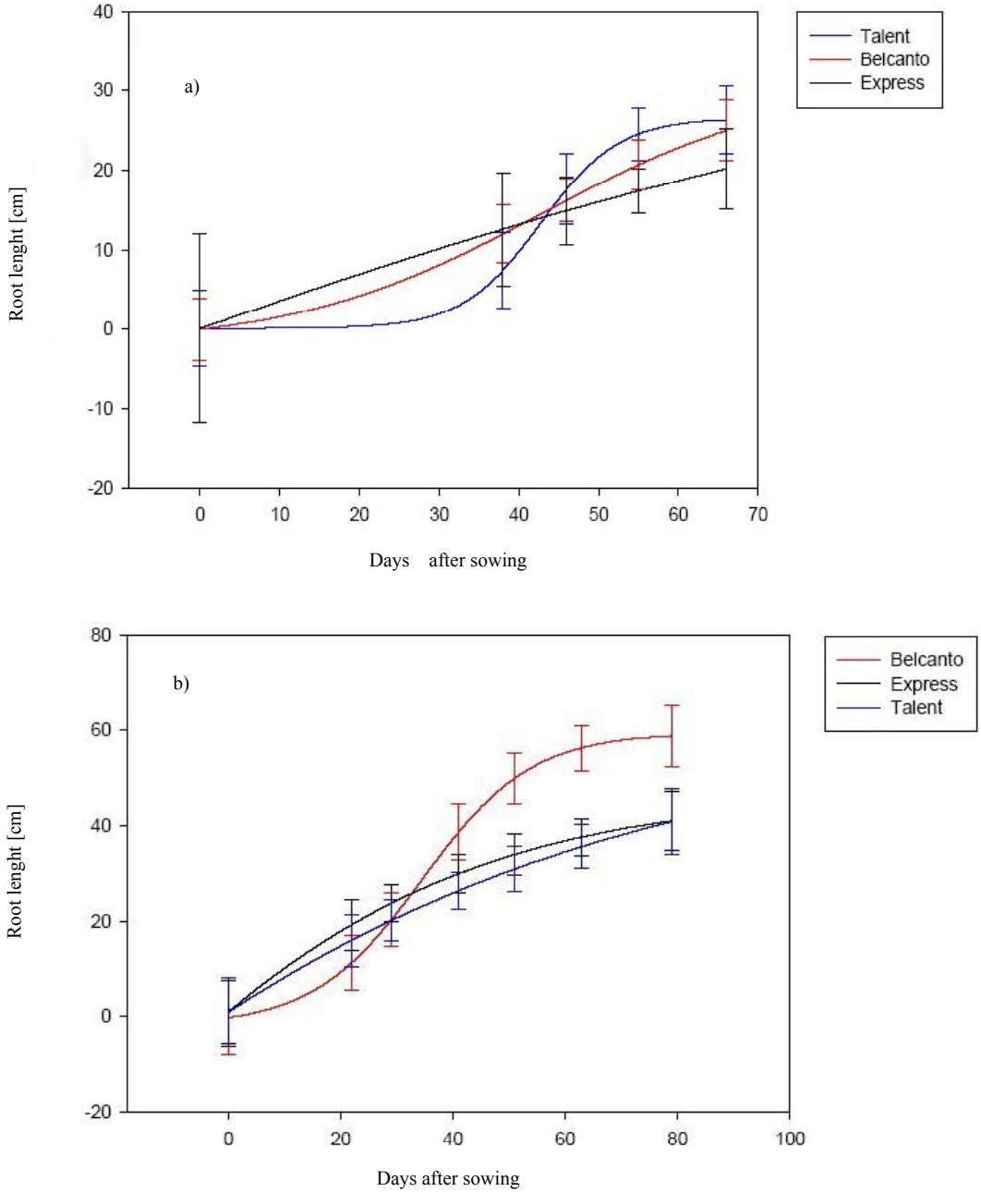

Fig. 1: Effect of variety on root length in early a) and late b) sowing in autumn 2003

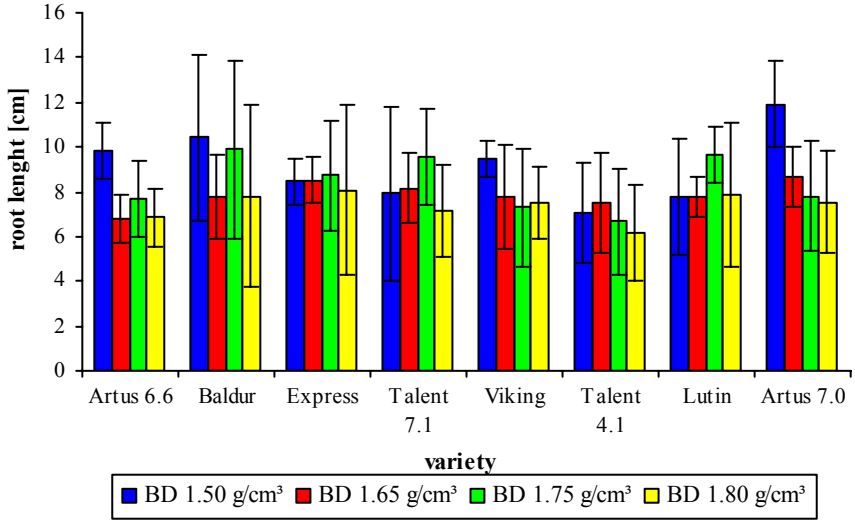

Fig. 2: Effect of variety on the root length [cm]

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