

Lentil-barley mixed cropping with different lentil varieties and sowing dates

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Lentil is a neglected crop in German agriculture for about 50 years. Due to its symbiotic nitrogen fixation, high nutritive value and the necessity of mixed cropping with a companion crop, lentil is highly appropriate for organic farming. Many open questions emerged when farmers started to re-introduce lentil into German organic farming some years ago. Two questions were investigated in a field experiment at the Experimental Station Kleinhohenheim of the University of Hohenheim, i.e. 1. the suitable lentil genotype, and 2. the sowing date. Four lentil genotypes were sown in a mixed cropping system with naked barley at three dates in spring 2009. The yield was significantly highest at the earliest sowing date for lentil (3 t ha^{-1}) and barley as well (1 t ha^{-1}). Weed biomass was significantly lowest at early sowing ($30 \text{ g dry matter m}^{-2}$), thus sowing as early as possible in spring can be recommended especially as lentils were reported to be slightly frost-tolerant. The data from the second experimental year (not published) will confirm this conclusion.

Introduction

Lentil (*Lens culinaris*) with high nutritional value is grown mainly for human consumption on a global scale (Muehlbauer et al., 1995). The crop has potential benefits in organic crop rotations and intercropping systems due to symbiotic nitrogen fixation. Furthermore, lentil can make crop rotations even more diverse. There is currently an increasing market, for farm shops and retailers in a considerably high price segment. Growing of lentil and the research on lentil was neglected in Germany in the past for several decades. Nowadays, more and more growers begin to re-introduce the crop into German organic farming, but there is only little information such as the optimal sowing date. Currently, lentil is sown in April/May in agricultural practice in South-West Germany (Schwäbische Alb). This procedure offers enough time for false seedbed techniques (several passes) to reduce weed pressure, as lentil has only low competition capacity toward weeds. An earlier sowing date would provide more time for growing, especially under short-day conditions resulting in potentially higher yields. On the other hand, false seedbed techniques are not possible anymore. As some lentil varieties are reported to show frost-tolerance to a certain extent, an early sowing date might be possible. Aim of this study was to exploit the potential growth period of lentil in terms of productivity and competitiveness in a field experiment.

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Material and methods

A field experiment was carried out at the organic research farm Kleinhohenheim (48.7° N, 9.2° E, 700 mm, 8.8 °C, loam soil) of the University of Hohenheim, South-West Germany in 2009. Three sowing dates: early (7 April), medium (15 April) and late (4 May) were included in the study. These sowing dates referred to three phenological events: flowering of coltsfoot (*Tussilago farfara*), dandelion (*Taraxacum officinale*), and lilac (*Syringa vulgaris*). Four varieties of lentil: "Anicia" (green marbled, TGM 31 g), "Schwarze Linse" (black, TGM 20 g), "Hellerlinse" (brown, TGM 62 g), and "Berglinse" (brown coat with red inside, TGM 32 g) were mixed-cropped with spring naked-barley (*Hordeum vulgare*, cv. Hora) at each sowing date. The trial was a split-block design with four replications, in a total number of 75 plots. Individual plots consisted of 16 rows spaced 15 cm apart, with a length of 4.2 m. The target seeding density was 240 seeds m⁻² (lentil : barley=3:1). Crops were sown using a plot drill at a uniform sowing depth of 3 cm and harvested on 5, 11 and 27 August by hand, respectively. The sample area per plot was 1 m² (twice, 0.5 m²). The preceding crop was oat (*Avena sativa*). Grain yield, above ground biomass and weed biomass were recorded. Analysis of variance was performed using the SAS statistical program. The "mixed" procedure was used and the data were square root transformed to get a normal distribution and homogeneity of variance if necessary.

Results

Grain yield (dry matter) of lentil and barley decreased significantly with the sowing date delayed. Early sowing of lentil and barley both showed obviously the highest yield among three sowing dates (Fig. 1). Anicia and Berglinse obtained around 3.0 t ha⁻¹ grain yields, while Schwarze Linse and Hellerlinse yielded about 2.0 t ha⁻¹. Anicia had the highest yield while Hellerlinse had the lowest independently from sowing dates. The yield of barley was highest at the early sowing date as well with a mean of about 1 t ha⁻¹ and significantly decreased with postponed sowing date. Weed biomass ranged from 16 - 81 g m⁻² (dry matter), and was significantly lower at early sowing conditions than that in the medium and late sowing dates (Fig. 2). Crop maturity was quite at the similar time for the early and medium sowing date, but clearly later for the last sowing date.

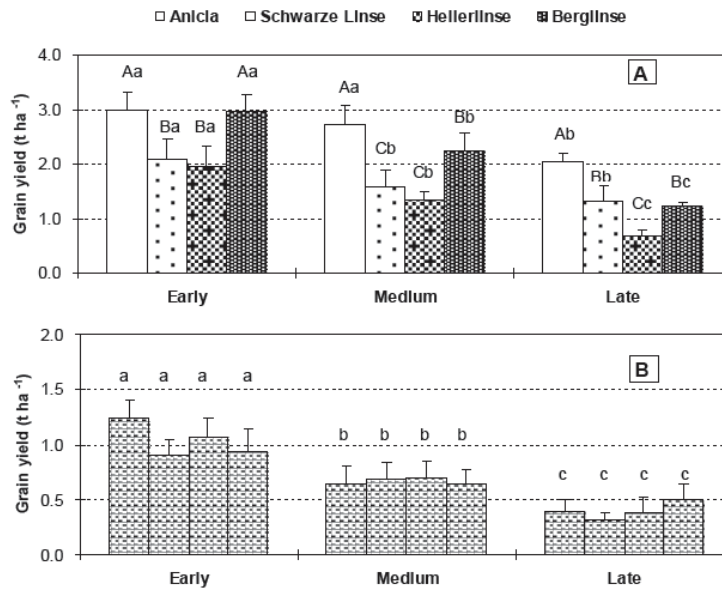


Figure 1: Grain yield (dry matter) of lentils (A) and barley (B) in different sowing dates (2009). Capitals: one sowing date all varieties, small letters: one variety all sowing dates; $P < 0.05$.

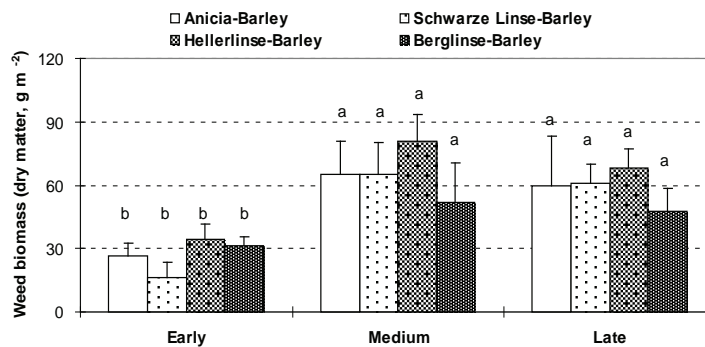


Figure 2: Weed biomass (dry matter) in four lentil varieties mixed with barley at different sowing dates (2009). Small letters: one variety all sowing dates; $P < 0.05$.

Discussion

Nowadays, organic lentil yield was not high. It was reported that a mean of lentil grain yield on organic farm in Greece was 0.56 – 1.38 t ha⁻¹ (Vlachostergios et al., 2010). Due to the

hand-harvesting with uprooting the total plant, the yield was much higher in our study than that in practical farming (i.e. $< 1 \text{ t ha}^{-1}$, W. Mammel, personal communication). However, our study indicated that earlier sowing is feasible for lentil-barley mixed cropping to get higher yields. One reason for this result may be the extension of the growing season and thus more accumulation of dry matter. On the other hand, development of the late sowing date seemed not to be faster than the development of the early sowing date, although it took 2 or 3 days less than medium or early sowing dates on seed emerging. There was no obvious difference among different lentil genotypes in seed emerge time. The dates of emerge were 21 April (early), 28 April (medium) and 15 May (late). The soil condition was dry and suitable for sowing on each sowing date and the amount of rainfall during the emergence period were 32 mm (early), 32 mm (medium) and 104 mm (late). Crops from the last sowing date reached maturity later than early sown lentils, so that the duration of the total growing periods was similar. Another reason for higher yields for the early sowing date could be a harvesting before a rainy period with hailstorms started. A third reason for higher yields is probably the more effective, indirect weed control by an early sown crop. The mixture of lentil with barley seemed to suppress emerging weeds because it provided more competitive conditions, particularly because tillering capacity and growth of the companion crop barley is highest at early sowing dates in spring. The competition of the Hellerlinse-Barley mixture was obviously low since weed biomass was highest compared to that at other sowing dates, which probably is one reason to result in lowest grain yield of Hellerlinse. This could be an effect of the growth habits of the lentil. The variety Anicia which showed highest yield performance is the crop grown in the local area, and it can be further recommended. Berglinse could be an alternative in terms of yield and grain color (important for consumers). However, at the moment, no varieties are commercially sold to growers in Germany. The data from the second experimental year will provide further information.

Conclusions

According to our provisional findings, early sowing for lentil in mixed cropping with cereals, particular barley, could be recommended for lentil growers. Local climatic conditions and weed pressure (annuals, perennials; soil seed bank) have to be considered when checking out the best time for sowing. The variety Anicia which is already widely used by growers seems to be a useful genotype, though others could be tested in terms of seed color, size and shape, or in terms of even better adaptation to local conditions. Breeding for those genotypes or using old, traditional varieties could be next steps in the story of re-introducing lentil into German organic farming.

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