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New process chain for seed harvesting from special crops on the example hemp

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Abstract

In Europe, hemp seeds are harvested primarily as a by-product of fiber hemp cultivation. As an additional yield is generated from cultivation, prices for fibers and shives can be stabilized or reduced. According to the available data, a yearly demand of approx. 12,000 t of hemp seed can be estimated for Europe at present. About 6,000 t are covered by European production, and about the same quantity is imported from Asia and North America.
An increase of approx. 50 % was recorded in production and marketing only between 2001 and 2005 (Carus, 2005).
Initially, seeds were harvested solely to cover the necessary amount of seed for the following season. By now, nutritional advantages of hemp seed, or the oil extracted from the seed respectively, are gaining more and more importance. The seeds contain, for instance, all eight essential amino acids and are therefore ideally suited as a protein source in human nutrition (Carus et al., 2008). Hemp seeds also contain omega-6 fatty acids linoleic and gamma-linolenic acid as well as omega-3 fatty acids alpha-linolenic and stearidonic acid in nutritionally optimal ratio.

Keywords: Hemp, Swath, Seed, harvest time

1 Introduction

Conventional hemp seed harvesting using a combined harvester is hardly possible under the climatic conditions of north and middle Germany. Therefore, an innovative machine and a processing chain are developed to attain homogenous and fully ripened seeds from swath. Experimental swaths have been prepared to investigate the impact of cutting time and post-ripening on seed quality and quantity. Results show that there was a time window of 9 days in 2012 for producing fibers of a good quality and harvesting a high quantity of seeds. Maximum yields were 364 kg DM/ha for variety Santhica-27 and 1,060 kg DM/ha for variety Fedora-17. The highest seed losses (22 %) were observed for variety Fedora-17. These losses occurred after the time of maximum yield.

2 Materials and methods

In order to investigate the post-ripening of the crops in the swaths, a standardized method of field-(or dew-)retting has been developed. For this purpose, two grids of 1 m² each with different mesh widths were tightened one above the other in wooden frames (Figure 1). The upper grid had a mesh width of 6 cm to ensure the ventilation of the swath comparable with the stacking on stubbles. The lower grid had a mesh width of 1 mm in order to collect falling

seeds. To protect them from animals, the frames were put up under a bird protection net in the open air.
The areas used for experimentally growing different varieties of hemp are situated in the immediate vicinity of the Leibniz Institute for Agricultural Engineering Potsdam-Bornim (52°26‘14‘‘N, 13°0‘58‘‘E). There are two plots with 0.31 ha each. On plot 9, the French hemp variety Santhica-27 was sown, on plot 10 the French variety Fedora-17. According to the specifications of the seed producer, these varieties differ in ripening behavior and especially in growing height.
The following tasks have been completed:

- 2012-05-03 ploughing
- 2012-05-06 harrowing with spring-tooth harrow
- 2012-05-15 sowing of the seeds with Accord Pneumatic DA (50 kg/ha)
- 2012-05-30 fertilizing with 80 kg/ha

Plant material for the trial swaths were put down on the frames in intervals of three days. The plants of 3 m² of each acreage were cut, counted and shortened to 60 cm – comparable with the lengths produced by common harvesting techniques – and loosely stacked onto the frame, inflorescences at the top. For the variety Santhica, trial swaths were arranged from 19th September to 3rd November 2012, for the variety Fedora from 10th September to 31st October 2012. On the whole, 18 trial swaths were produced for each variety. Each of these was turned after 10 days in order to ensure an even drying process. The experimental field retting was completed after 20 days. The mass of the seeds on the lower sieve was gathered and classified as losses. The inflorescences on the upper sieve were deseeded by hand. Afterwards, fresh matter, dry matter and organic dry matter of each sieve fraction were identified in the laboratory. In addition to that, both the ripening stage of the crops on the field and the progression of the retting were regularly determined and documented by plant surveys.

Figure 1: Experimental swaths under a bird protection net (Photo: ATB)

The organic dry matter of the harvested and fallen out seeds of the respective trial swaths was related to the number of the crops cut on 3 m². After the completion of the swath trials, the mean value of the number of plants per 3 m² was extrapolated to one hectare. From these values (seeds per plant, plants per hectare), the seed yield in kilogram dry matter per hectare was calculated.

3 Results and Discussion

The comparatively late sowing in the middle of May instead of beginning to end of April is due to the weather conditions in 2012. Therefore, the end of bloom was reached comparatively late. It is recommended to cut and put the crops into swaths until the middle of August, because after this time the drying in the swath and a good field-retting can be impeded by weather conditions (Gusovius, Prochnow, Streßmann, Hahn, 2000). Figure 2 shows the relation between growth period and dry matter content of the harvested seeds in relation to the seed yield of the varieties Santhica and Fedora in 2012.

The increase of dry matter content of the seeds at a progressing cutting time is clearly visible. At the same time, the seed yield increases. For the production of hemp fibers, the recommended sowing time lasts from beginning to end of April and the recommended cutting time is not later than middle of August (Graf, Reinhold, Biertümpfel, Zorn, 2005). This corresponds to a growth period of 107 to 136 days. In the present study, the highest seed yields were obtained in a period of 127 to 154 days after sowing. A dry matter content of 40 to 75 % was determined. Following the recommendations, the production of high-quality fibers in combination with high seed yields would have been possible in a time slot of 9 days.

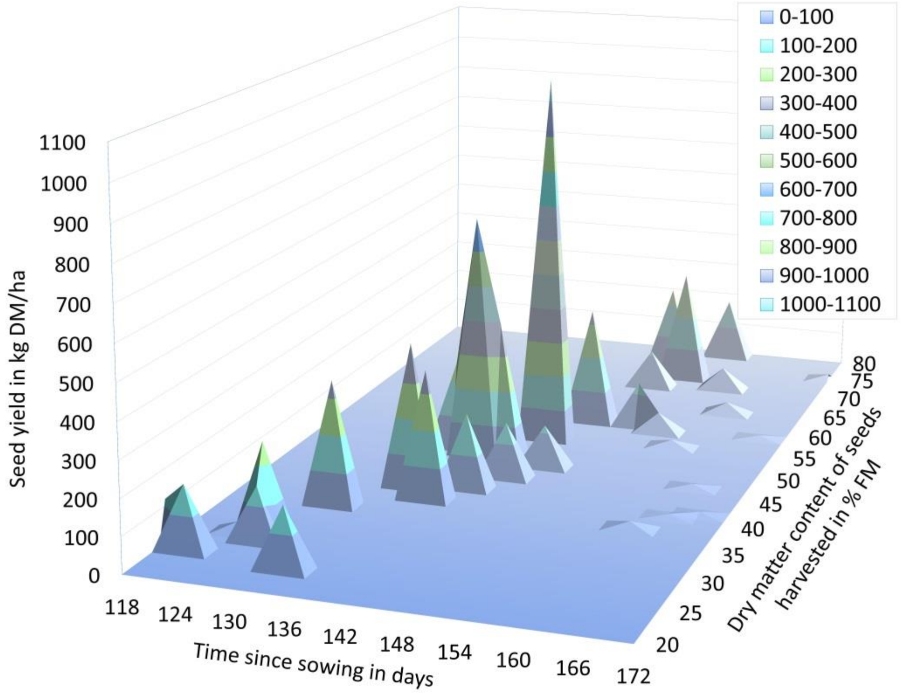

Figure 2: Seed yields and dry matter content of seeds obtained within trial period from 2012-09-10 to 2012-11-03 of the species Santhica-27 and Fedora-17

In Figure 3, the differences between the two varieties as well as the respective fractions of the seeds obtained and the seeds lost are shown in detail. The variety Santhica had its yield maximum of 364 kg DM/ha 139 days after sowing. Thus, the maximum yields of the variety Santhica lie far below the values given in the literature for conventional techniques of seed harvesting (Karus & Kupfer, 2003). The variety Fedora had its yield maximum 6 days later. This was much higher: 1,060 kg DM/ha seeds. Thus, the maximum yield lay in the midfield of the values given as yields of Fedora (950–1,200 kg/ha for Fedora-19). It has to be assumed, however, that the values given in literature are related to a residual moisture content of 12 to 15%, the maximum residual moisture content for ensuring storage properties, and not – like in this trial – to the absolute dry matter (drying at 105°C to constant weight). Furthermore, the varieties showed very different time periods according to maximum yields: the variety Santhica in a period of 127 to 139 days, the variety Fedora from 136 to 154 days after sowing. This displacement contradicts the information given by the seed producers concerning the time of ripeness in which Fedora is given as an early variety, Santhica as an average one (Desvals, 2006).

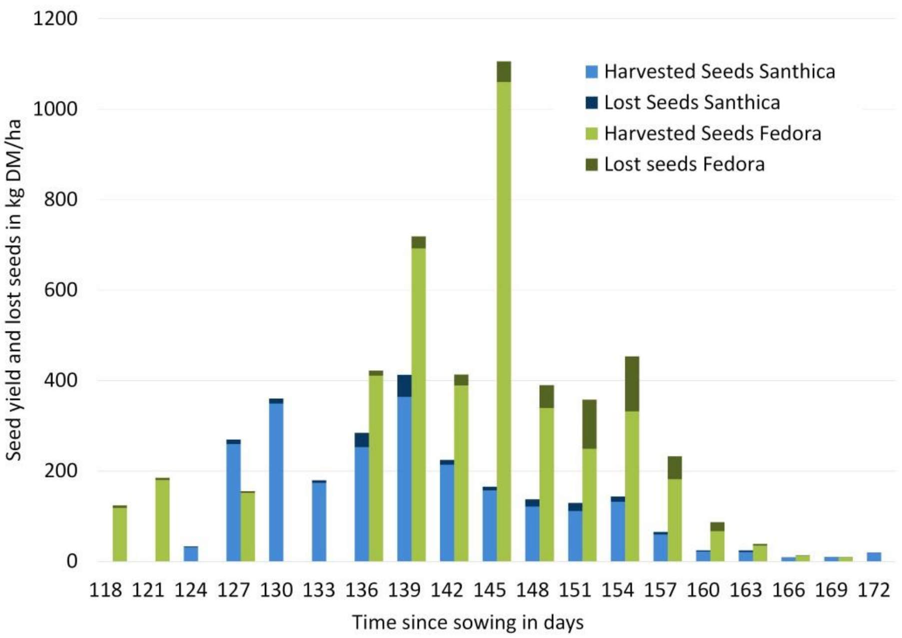

Figure 3: Relation between seeds obtained and seeds lost within trial period from 2012-09-10 to 2012-11-03 of the species Santhica-27 and Fedora-17

Towards the end of the trial period, the seeds of the variety Fedora showed a strong tendency to fall out. In this respect, a maximum is reached 154 days after sowing: 122 kg of 554 kg of dry matter fell out during field-retting, this corresponds to a loss of 22 %. The tendency of the seeds to fall out is dependent on the respective variety. This is of special relevance to the intended process chain as the swath is to be taken up from the field together with the inflorescences lying in the swath in order to deseed it. During this procedural step, significant losses are to be expected.

4 Conclusions

Despite the losses occurring during cutting and swathing, it has been shown that yields comparable with yields of conventional harvesting techniques are possible. The determined time slot with high seed yield correlates with the time slot recommended for fiber harvest. Special attention should be given to the choice of variety, as varieties with high losses can reduce the possible seed yield substantially. As the swaths are deseeded during the inevitable turning of the swaths, no additional procedural costs arise. The machine currently developed is to be completed as a trailed implement. Comparatively low investment costs are to be expected.

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