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Ridge Cultivation of Sugar Beets

Sugar beets have been experimentally cultivated in ridges in Northern Germany since 1999. The purpose is to prevent water accumulation in the root zone and take advantage of faster soil warming in ridges. Here experimental results from two ridge cultivation methods with precision seeding from 2003 and 2004 are introduced. The test plots were located in the Cologne/Aix-la-Chapelle region. Beets grown on ridges have longer roots and were harvested with less soil tare. Compared to conventional cultivation a tendency towards higher yields is noticeable.

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Keywords

Sugar beets, ridge cultivation, soil tare, precision seeder

Sugar beets have contributed a relevant part to the economic success of root-crop-cultivating farms for many years. However, as a consequence of a revision of the European market organisation for sugar it must be assumed that the general economic conditions for the cultivation of sugar beets will be significantly get worse. It is therefore necessary to tap the full potential of enhancing profitability. Since ridge cultivation can foster the early development of sugar beets, this system has been increasingly taken into consideration as an alternative cultivation method in the last five years.

Cultivation methods

In Germany, sugar beets are grown on an acreage of 445 500 ha. The cultivation sites are characterized by good soil conditions. In the Western federal states the growing sites are concentrated in a few regions only, whereas the Eastern federal states have a more decentralized sugar beet production, which is due to the development of the agricultural structures in the post-war period. Nevertheless, for seedbed preparation and sowing largely the same techniques are applied. These include a finely crumbled seedbed and sowing with precision seeders which provide for a uniform seed spacing of pelleted seeds.

In the last decade, changes in cultivation methods were dominated by an increase of mulch cultivation which is connected with no-plough tillage. Furthermore, the use of tramlines is attracting more interest. Ridge cultivation of sugar beets is already well known in areas which depend on irrigation. Under these conditions, ridge cultivation is expected to prevent a build-up of moisture in the beets' root region.

In Germany, ridge cultivation was first applied on heavy marshy soils [1] in areas which dispose of technical equipment for the cultivation of carrots on ridges.

The following advantages can be stated [3 - 7]:

- reduced sensitivity to moisture build-up
- accelerated warming of the soil in spring
- easier separation of soil and beets
- higher yields due to better aeration of the soil and improved early development of the beets
- beneficial soil temperatures and better water supply

The machines/implements utilised for this technique consist of a ridge-forming rotavator, followed by a ridge roller and a hooked up precision seeder.

Depending on the soil conditions, the one-phase operation is sometimes preceded by a secondary tillage to promote the drying of the soil.

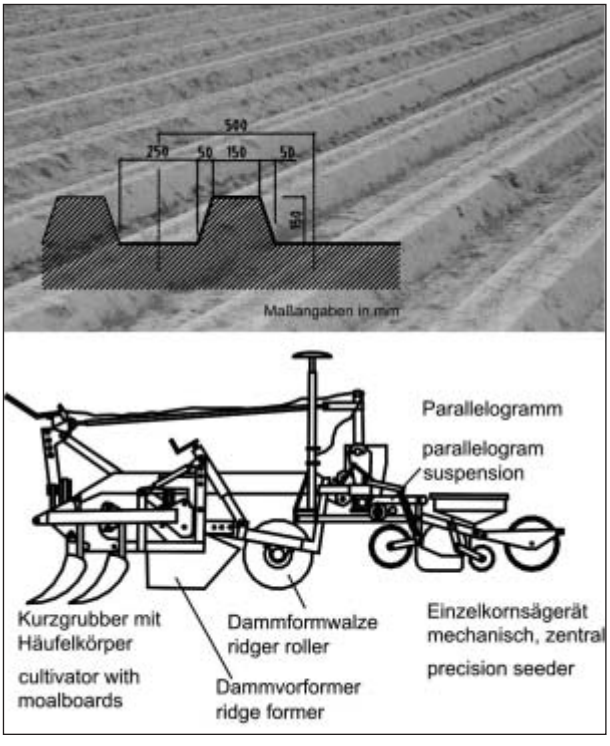

Fig. 1: Photo of ridge cultivation of sugar beet with dimension of ridges after seeding and scheme of implement combination

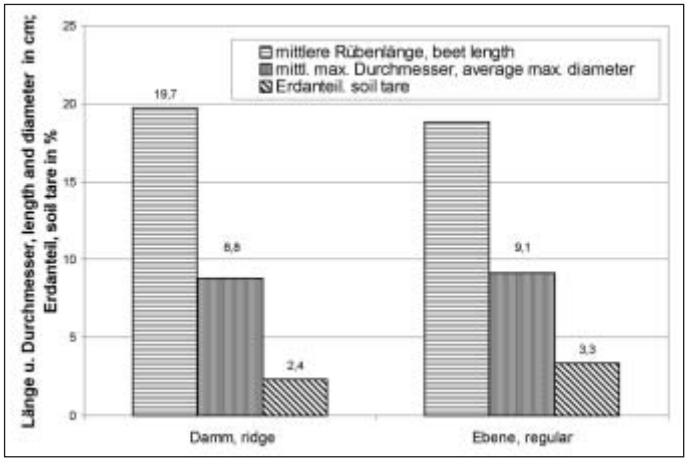

Fig. 2: Comparing morphological data and soil tare, location: Klein Altendorf, 2003 and 2004; conventinal and ridge cultivation; primary tillage: plough

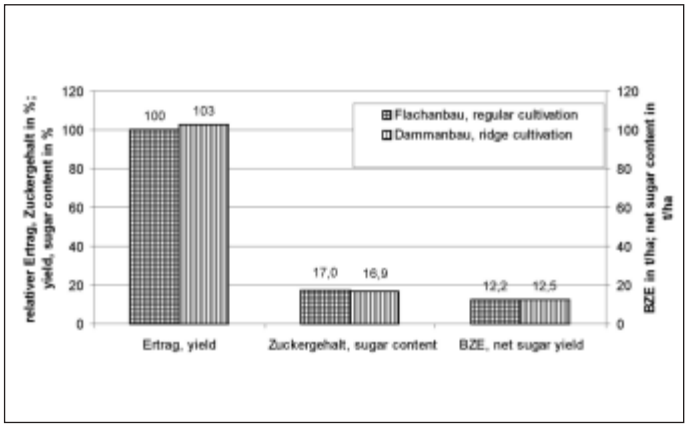

Fig. 3: Comparing yield, sugar content and net sugar yield for conventional and ridge cultivation; mean of 11 locations in the Rhineland, 2004, conventional cultivation 100 %

Ridges are formed with a top width of 15 cm, a height of 15 cm and a row spacing of 50 cm (*Fig 1*). This process ensures a reliable pre-forming of the ridges by means of the propelled tillage implement and a fine texture in the sowing horizon within the ridge.

The ridge rollers provide for a sufficient recompaction and an exact geometry of the ridges. The rollers are propelled to allow for an undisturbed rolling motion. The pressure needed for recompaction results from the weight of the entire implement combination which is supported by the ridge rollers.

The precision seeder's driving wheels run between the ridges. Therefore the wheel suspension must be lowered according to the ridge height. Furthermore, an auxiliary spring is necessary to prevent the ridges from being crushed by an exceedingly high pressure of the shares.

The performance is determined by the row number of six units and by the operating speed which is limited by the driving power of the rotavator (120 kW at 6 km/h).

At the Institute of Agricultural Engineering of the University of Bonn another one-phase technique was developed to reduce the power requirements and the resulting fuel consumption. The combination consists of mouldboards arranged in a staggered formation on a two-bar frame, ridge formers, a propelled ridge roller and a precision seeder. The ridges are pre-formed by the mouldboards and the ridge formers. The subsequent process phases correspond to the first-mentioned technique.

While offering the same working width and operation speed the new implement combination demands for a significantly lower power of 50 kW.

The shape of the ridges is the same with both techniques. It results from the geometry of the ridge rollers and from the requirements as regards the use of conventional harvesters.

Cultivation experiments

Experiences of several years were gained for technique I from the area "Heide" in Schleswig Holstein. In 2004 technique II was implemented on 11 sites in Rhineland after a test stage on an experimental farm of the University of Bonn.

Due to a bigger surface, the expected acceleration of the warming of the soil could be observed. This effect occurs until the canopy shadows the soil surface which strongly diminishes the impact of solar radiation.

In spring the emergence was assessed and in autumn all relevant crop parameters were determined when the beets were harvested. Furthermore, yield data and soil tare were gauged.

Since the beet roots grow deeper into the soil, the height at beet top is about 2 cm less. Comparing ridge cultivation and regular cultivation, there are only small differences in the maximum diameter of the beets. By contrast, the soil tare is smaller and the beets' length (measured between crown and a diameter of 4 cm) is about 1 cm bigger in the ridge cultivation system. The smaller soil tare of the beets from ridge cultivation can be explained with an easier extraction of the beets and better separation of attached soil.

In the years 2003 and 2004 the population density at harvest time was between 82000 and 87000 beets per ha, higher than population density on experimental sites with regular cultivation. It cannot be assumed that the plant densities which comprise only a small range have a significant influence on the yield. Yields on the sites in Rhineland were slightly higher in ridge cultivation, while sugar contents showed no pronounced differences. Accordingly, only marginal differences which are not be statistically significant occurred in net sugar yields.

Summary

Two one-phase techniques for the ridge cultivation of sugar beets were introduced.

The system which has been implemented in the cultivation of carrots for several years works with a propelled tilling device, while a simpler system makes use of mouldboards.

In the years 2003 and 2004 field tests were designed on an experimental farm of the University of Bonn and on several sites in Cologne-Aix-la-Chapelle region.

In the tests on the Universityís experimental farm at Klein Altendorf of the first year which was dominated by extreme weather conditions no increase in yield could be measured, but a positive influence on length growth and a smaller soil tare were observed.

In the second year there was a tendency towards higher yields in the field tests. In addition, the stronger length growth and the smaller soil tare of the beets from ridge cultivation could be confirmed.

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