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ROOTS CAN REPLACE THE PLOUGH

How cover crop mixtures take over soil tillage in the Kraichgau

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The best soils in Europe are in the Kraichgau, in the north west of Baden-Württemberg. A highly erodible covering of loess and a percentage of silt nonetheless pose a challenge for farming. A soil like this suffers from compaction, if, as is the case today, 80 % of the land used for agriculture is used in mulch sowing processes. Even growing cover crops, currently consisting of sole crops of phacelia, mustard and oil radish, has no effect on loosening the deep soil. A group of resourceful farmers found an approach to solving the problem in cooperation with the Office of Agriculture, using a variety of cover crop mixtures to loosen the deep soil.

The Kraichgau is marked by its mighty coverings of loess, the substructure of which is made up of Early Triassic variegated sandstone, Middle Triassic Muschelkalk, Upper Triassic Keuper and Jurassic. The soils are among the most fertile agricultural soils in Central Europe. Because of its high percentage of silt, the loess is also a highly erodible soil. By reason of this risk of erosion, with the introduction of mulch sowing processes, the growing of cover crops has become established in the last 25 years and has meanwhile become a fixed component in crop rotations. The growing of cover crops was able to go some way towards solving the erosion issue and also the nitrate issue in the water protection areas. The water protection regulations and the promotion of mulch sowing and greening through the Baden-Württemberg „MEKA“ environmental programme meant that in the Kraichgau more than 80% of the land used for agriculture is now farmed by mulch sowing processes and is greened to a corresponding extent by cover crops. In this programme principally mustard, phacelia and oil radish have been grown.

In the attempt to minimise the intensity of working the soil, it is often loosened only down to sowing depth. The loess soils in the Kraichgau however tend to compact relatively quickly with minimal intensity of working the soil. Consequently, these reduced processes did not produce any satisfactory yields. The soil structure was

usually too compact and too little aerated. As a rule, the proportion of coarse pores was too low and the crumb structure not satisfactory.

A group of farmers got together to solve these problems with the help of the Bruchsal Office of Agriculture.

Cover crop mixtures – an approach to solving the problem

An approach to solving the problem was found in growing cover crop mixtures in conjunction with a diversified crop rotation. In comparison with the cover crops usually grown in the Kraichgau – mustard, phacelia and oil radish – cover crop mixtures provided a significantly more intensive root penetration of the soil, both horizontally and vertically.

Just before planting, maize specific cover crop mixtures are grown, which specifically promote the mycorrhiza of maize and thus improve soil structure. The soils become more stable and water-stable and working the soil becomes easier. The intensive root penetration of the various components of the cover crop mixtures creates



TerraLife MaisPro cover crop mixture in the Kraichgau.



new root passages. This improves the soils' infiltration capacity and ensures distinctly better protection against erosion and improved water retention. In its turn the maize is able to take advantage of this in periods of drought.

The various root excretions of the various components, known as root exudates, have a lasting effect on the nutrient level and life in the rhizosphere. They serve to feed the micro-organisms, release nutrients and promote crumb formation. Consequently, in well-developed cover crop mixtures it is sufficient in spring to work the soil to the level of the maize deposit horizon. Thus capillarity is retained, which ensures that there is water available for the shoots.

Which seeding process?

Which seeding technique is the right one, was one of the most important questions considered by the farmers. The positive effect effects of the cover crop mixtures suggested to their minds that the working of the soil should be minimised to correspond with the seeding of the cover crop mixtures. The roots of the cover crop mixtures should undertake the „job“ of working and loosening the soil. Practice trials were carried out to test that the cover crop mixtures are established. Every possibility was tested from the system of the traditional double stubble working (first shallow, then deep) through the direct sowing after

harvesting with a rotary harrow seed drill combination up to direct sowing of the cover crop mixtures.

The most extensive process was the sowing of the cover crop mixture prior to the cereal harvest, pre-harvest sowing. The important thing in this is a deep cutting height, short chopping of the straw and exact distribution of the straw. The cover crop mixture sowed with the pre-harvest sowing germinates relatively quickly. All the components develop well and consistently, so that as a rule by the end of September a very thick stand develops up to a metre high.

Direct sowing without the traditional stubble working likewise represents an extensive process. Seed is sowed directly behind the combine harvester. In this process the cover crop mixture can be established with a combination of rotary harrow / seed drill, disc harrow / seed drill or other combinations. Admittedly, with this process the areas must not show any problems of abundance of „old“ weeds. Practical trials were also conducted with cover crops mixtures from 2011 to 2015. The trials were sowed with Dutzi-Visio. From 2013, as part of a project with Hohenheim University and Nürtingen University of Applied Science, the Amazone DMC Primera 602 direct sowing machine was used. Here also direct sowing after threshing is an important factor, so that volunteer grain and weed seeds do not become established.

The extensive methods illustrated offer the advantage that the volunteer grain and the weed seeds gain no initial lead over the cover crop

seeds, which is usually the case in traditional stubble working. In this way good, thick stands develop relatively quickly. Moreover, the methods of working the soil only down to sowing depth and direct sowing save water. Consequently there is more moisture in the soil for the cover crop mixtures soil moisture retention in subsequent drought than in intensively worked and loosened soil.

Improved soil structure

In all the sowing methods tested the root penetration of the soil by fine and coarse roots was very intensive and produced a very good crumb structure, which was retained up to the working of the soil prior to sowing the maize in the spring. Since 2011 a marked increase in the earthworm population in conjunction with an improved soil structure has been recorded on the extensively worked businesses. This can also be measured in increased rainwater retention. Since the stands of cover crop mixtures remain over winter, in the case of maize until shortly before sowing, the crumbly, but yet stable soil structure is also retained over winter. The earthworms can continue being active and reproducing on these areas. In March the condition of the cover crop mixture determines the next processes on the area. After corresponding periods of frost in the winter they are well frozen off. As a rule working the soil to sowing depth, a few days before sowing, is all that is needed. At this point machines such as Dyna-Drive, disc harrows or cultivators are used. Many businesses even refrain from working the soil and sow the maize directly into the stand of dead cover crops. The important thing, whether the maize is sowed by mulch sowing or direct



Pre-harvest sowing with a pneumatic fertiliser spreader.



Root penetration of the pre-harvest sowing.



Direct sowing without traditional soil working with Dutzi-Visio.



Frozen cover crop mixtures shortly prior to sowing the maize.

sowing, is that the seed drill is fitted with appropriate „roughing tools“ and cutting discs. This prevents clogging and the grain of maize is cleanly deposited in the soil.



Earth worm faeces on an area directly sowed with cover crop mixtures.

If cover crop mixtures contain peas and/or vetch, the stand is already „pulled under“ during December. In this way the plants are given slight contact with the soil and can pass more quickly into the rotting process. This is a particularly major advantage when there have been no periods of frost, as was the case in the Kraichgau in the winter of 2013/2014.

After a frost-free winter it is advisable to work the soil at a shallow level two to three weeks prior to sowing. In some case there is also no need to mulch the stand beforehand.

The situations illustrated have been supervised by professionals as part of a practical trial. In this cover crop mixtures were sowed by various methods (deep mulch sowing, shallow mulch sowing, direct sowing) on Horst Sandbühler's farm in Kraichtal. Over the three years of the trial the mixtures on the direct sowing model showed the best development. In 2013 in the direct sowing model the effect on the yield of the various cover crop mixtures was identified on the maize crop rotation. The results are set out in the following table.

The N fertilisation was carried out with due regard to the respective nitrate values prior to sowing and to the anticipated release of nitrogen by the individual cover crop mixtures and the mustard. The level of nitrogen fertilisation lay between 50 and 90 kg N/ha. The influence of the individual mixtures can be clearly seen in the yields. The factors of the release of nitrogen and nutrients, the loosening of the soil, the crumb

Effects of growing cover crops on grain maize yields

Variants	N ferti- sation in kg/ha	Yield in dt/ha
Kraichgau mixture 1 *	90	132
Kraichgau mixture 2 *	90	135
TerraLife Rigol	90	131
TerraLife N-Fixx	60	140
TerraLife MaisPro	60	144
TerraLife BetaMaxx TR	60	131
TerraLife AquaPro	90	117
TerraLife BioMax TR	90	115
Mustard	90	121
„Bio strip“ with tillage radish	50	122

structure and the mycorrhiza output were definitely influential. With respect to these factors the MaisPro mixture has an obviously very well-balanced effect on the maize crop. The yield here was clearly the highest with 144 dt dry matter per ha. At 121 dt dry matter the mustard variant was placed 23 dt lower.

Summary

The question whether the roots of the cover crop mixtures can undertake the „job“ of working or loosening the soil, can definitely be answered with a „yes“. The roots and their „excretions“ link up with the activity of the soil biota, which they have stimulated, in a totally natural way. This process has a long-lasting, stabilising effect on the soil structure and the tilth. The alternative to this, frost action, is, however of a shorter duration.

If, instead of sowing sole crops, such as mustard, suitable cover crop mixtures are used, the working of the soil for sowing maize can be minimised or the maize can even be sowed directly. The practical trials in the Kraichtal also showed their effect on yields, since TerraLife MaisPro produced a 23 dt higher yield.



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