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Work Quality of Seedbed Preparation depending on Soil Moisture

Soil moisture content is decisive for tillage quality and seedbed preparation. On homogeneous plots, a satisfying result is possible if done at the right tillage time. However, on heterogeneous fields tillage success varies within the field.

The soil water content is influence by different factors. There is the soil type which informs about the percentage of sand, silt and clay in a soil. If the soil type is known, the soil water retention curve and the hydraulic conductivity can be derived from the van Genuchten equation [1]. In the last 100 years the term of potential is used in a context of soil water. Potentials describe the binding of water to the soil. The potential of a soil is considered as a sum of component potentials (matric, gravitational, pressure and osmotic potential) shown in equation 1. The water retention curve combines the matric potential and the soil water content.

$$\psi = \psi_m + \psi_z + \psi_g + \psi_o \qquad \text{Eq. 1}$$

Changes in topography lead to changing gravitational potentials. If there is the same sum of component potentials on a hilltop and in a valley, the higher gravitational potential on the hilltop leads to a lower matric potential in comparison to the valley. This consequently leads to a higher water content in the valley than on the hilltop.

The soil water content is not only influenced by other factors, it also affects soil properties like hydraulic conductivity, specific heat capacity, trafficability and consistency. The inner binding of soils is defined as the soil consistency. The consistency thresholds had been defined by Atterberg (*Table 1*). Consistency depends on the soil type, the amount of exchangeable cations as well as on the salt concentration. With very high soil water contents soils have the properties of fluids, while with very low soil water contents they behave like solid states. Therefore soils are considered as macromeritic liquids and rheological techniques are used.

The soil water content has influence on the tillage

The optimum water content for tillage is defined as the moisture content of soil at which tillage produces the largest number of small aggregates [2]. Bhushan and Ghilday [3] found the optimum water content for tillage at 0.77•pl (plastic limit acc. Atterberg, table 1) on a sandy loam. On a comparable soil Ojeniyi and Dexter [4] found the same point at 0.9•pl. Further works pointed out that the optimum water content for tillage is found at the inflection point of the water retention curve. With the parameters and the formula of van Genuchten [1] it is possible to find the inflection point for every kind of soil. Dexter and Bird [2] found beside the optimum water content for tillage a range of minimum and maximum water content where tillage still produces a decent size of aggregates. Outside of this range, tillage does not lead to a satisfying aggregate size distribution: too wet or too dry soil produces big clods instead of small aggregates. *Figure 1* shows the optimum, minimum and maximum water content for tillage depending on the clay content. The results from Lyles and Woodruff ([5], *Fig. 2*) confirm the investigations by Deyter and Bird. .

Table 1: Consistency thresholds acc. to Atterberg

Wassergehalt	Zustand	Konsistenzgrenze
hoch	flüssige Suspension bis Paste	
		Fließgrenze (Wf)
mittel	kohärente, breiige, zähe Paste	
		Ausrollgrenze (Wa)
niedrig	brüchige, sehr steife Paste	
		Schrumpfgrenze (Ws)
	harter Block	

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Keywords

Soil tillage, soil moisture, seeding, precision farming

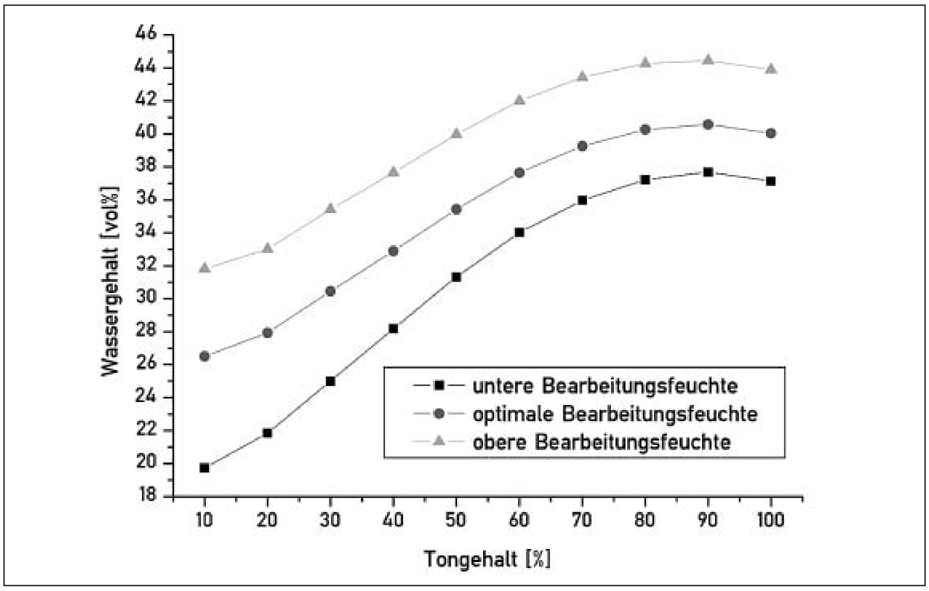

Fig. 1: The effect of clay content on optimum tillage moisture

The Importance on Heterogeneous Fields

Different kinds of soil and changing topography lead to different water contents and water retentions on heterogeneous soils. This means that not only the water content varies within a field; the values for optimum, minimum and maximum water content also vary. Therefore the quality of tillage changes on a heterogeneous field, especially for the seed bed preparation. The time for tillage is also a decisive factor. On the field Binsensee, which belongs to a research station of the University of Hohenheim, the soil water content was measured on three different times (April 13th, April 15th and May 12th). It is a heterogeneous field with the size of 10 ha. . The kind of soil varies from silty sand to clay and offers a broad research spectrum. The soil water contents on the three dates had been above or below the optimum soil moisture for tillage on almost the whole field. On the first date 3% of the area had been out of the tillage range. But two days later there were already 54%. This results show on one hand that there is now way to attain an equal quality of seedbed preparation on heterogeneous fields and on the other hand how important timely tillage is.

For a fast and possibly complete emergence it is important that the seedbed preparation produces many small aggregates. Hadas and Russo [6] found out that an aggregate size of 1/5 to 1/10 of the seed diameter is most favourable for a high emergence rate. Johnson and Taylor [7] determined the highest plant density of maize on soils were 30% of the aggregates were smaller than 2 mm. Schneider and Gupta [8] use the geometric mean diameter (GMD) to classify different aggregate size distributions. Lower emergence rates of maize were found for very small (GMD=0.5 mm) and big values (GMD=11.9 mm).

Conclusion

The heterogeneity of our fields leads to different aggregate size distributions within the fields. Therefore the cultivating methods have to react to the different circumstances within the field. Conceivable are site-specific seedbed preparation methods as well as cultivation methods where the seeding depth or the seeding density varies, depending on the changing germination conditions.

Literature

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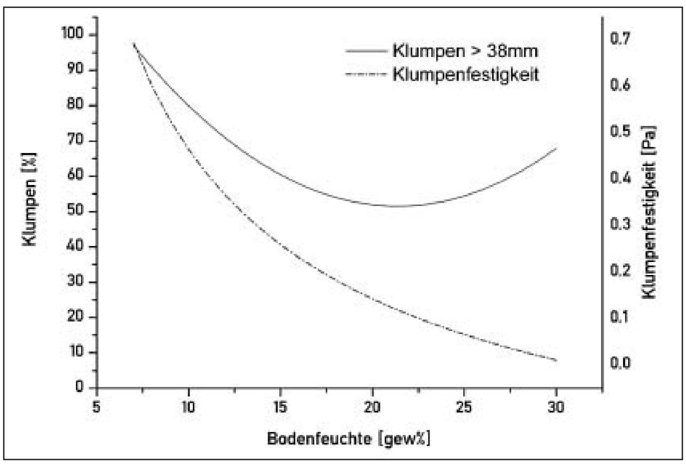

Fig. 2: Percentage of big clods versus soil moisture