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ASSESSMENT OF SOIL FERTILITY UNDER DIFFERENT CULTIVATION USING BIOLOGICAL INDEX IN ORGANIC FARMING

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Index

Abstract

The community of Schloss Tempelhof, was born in 2010, since its begin, focused one of its pillar on agriculture. The main goal pursued with agriculture is to feed the community and the customer from the neighbour villages using organic agricultural principles.

The firm will of the community to create a long term sustainable farming has led to the creation of a collaboration between the community and some Universities in Germany. The first objective of this partnership is the description of the status quo of the soil properties with chemical, and biological parameters. In this research three physical parameters were calculated: dry matter, water holding capacity and bulk density and a biological parameter: the amount of microbial biomass in the soil. This is an important ecological parameter: the microbial biomass is strictly involved in nutrient cycling processes and regulates many organic matter transformations. The aim of the research is to analyse and compare the microbial biomass of 11 different soils collected from different fields under different cultivation. The result will help the farmers to understand which techniques improves and which alter the microbial biomass present in the soil.

1. Introduction

Organic farming was formally established for the first time with the European Council Regulation (EEC) No 2092/91 of 24 June 1991, with the definition of organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. The European Council updated the rules of organic production of 1991 with the law EC No 834/2007 of 28 June 2007 and the implementing regulation listed in the annexes of Commission Regulation EC No. 889/2008. The new regulation promotes the following principles: sustainable cultivation systems, high-quality products, environmental protection, attention to biodiversity and animal welfare, closed cycles using internal resources and inputs are preferred to open cycles based on external resources.

Since its institution the organic farming has constantly increased, nowadays 50.9 millions of hectares worldwide are cultivated following its principles (FIBL & IFOAM, 2017). Europe counts 25% of the organic agricultural land (12.7 millions of hectares) and it is the second largest organic agricultural continent after Oceania. Germany is one of the ten countries with the greatest organic agricultural land counting 1.09 million of hectares (6,5% of total agricultural land). Organic retail sales have an important market worldwide with approximately 75 billions Euros, of which Europe is the second largest region market with 29.8 billions Euro. Germany is the second country with the greatest market for organic food with 8.6 billions Euro (FIBL & IFOAM, 2017). Watching organic agriculture from another perspective, it could play an important role toward the sustainability of food system: it focuses on soil fertility promoting crop rotation, closed nutrient cycles and refraining the use of synthetic pesticides and fertilizers (Foley et al., 2011, IAASTD, 2009). Many studies reported the positive performance of organic agriculture when measured with environmental indicators (Muller et al., 2017, Schader et al., 2012).

Soil is commonly defined as a layer of variable thickness of biogeochemically altered rock or sediment at earth's surface, characterized from its geological sources (Jenny, 1941). Undisturbed soils are able through many different mechanisms to retain many of their features indefinitely over the time (Amundson et al., 2015). Domesticated soils, on the other side, seldom are able to maintain their original conditions. Most of modern agricultural practices remove natural flora, simplify the biodiversity toward monocultures, this changes affect long term productivity and geochemical cycles (Amundson et al., 2015).

Soil biota play an important role in the ecosystem self-regulating processes and in the provision of various ecosystem services as supply of nutrients, maintenance of soil structure and water regulation (Eekeren et al., 2008). Soil microbial biomass is an important ecological indicator, it is responsible for degradation and mineralization processes of soil organic matter (Marinari et al., 2006). Changes in microbial biomass may cause variations in some important ecological function such as nutrient cycling and organic matter decomposition. The microbial biomass respond faster to changes in soil condition than soil organic matter (Brookes et al., 2008). Changes in the structure of microbial communities are caused by many different factors: plant diversity (Carney and Matson, 2005), plant species composition (Kourtev et al., 2003), management practises (Welbaum et al., 2004) and soil type (Garbeva et al., 2004). However how the microbial communities structure change in relation to these factors it is hard to predict due to the many interactions (Hamer et al., 2008). The composition of microbial community may have important implication for ecosystem function (Fraterrigo et al., 2006). Variations in soil biota and ecosystem functions may affect agronomic aspects such as the plant growth, plant community composition and diversity (Schloter et al., 2003; Orwin et al., 2006). Several previous studies have shown that changes in the management practices can alter the microbial community (Visser and Parkinson, 1992; Schutter and Dick, 2002; Liebig et al., 2006; Yao et al., 2006; Elfstrand et al., 2007). According to Steenwert et al. (2005) the intensification of agricultural practices like the use of pesticides, herbicides and irrigation decrease the microbial diversity and reduces the resistance of the microbial community to changes after perturbation. Soils represent a heterogeneous environment for the microbiota that lives in it. The different components provide many different microhabitats formed by soil aggregates. Soil aggregates are groups of soil particles that bind to each other more strongly than to adjacent particle, they form a complicate pattern of pore spaces of different sizes and shapes filled with air or water (Young and Ritz, 2000; Jiang et al., 2011) and represent an ecological niche for microbial biomass (Lavelle et al., 2006). The aim of this work was an on-farm soil sampling approach to underline which agronomical practices create the best conditions for the microbial biomass. The research compared eleven fields, nine of them managed, under different cultivation, using the principles of organic farming and two of them with conventional agricultural practices. In addition to this, the research tested some innovative techniques in the field of soil biology: the sampling process took place with powered soil sampler and the method of chloroform fumigation extraction was applied on a 4-millimeter sieved soil.

2. Material and Methods

2.1 Research site

Schloss Tempelhof is a community located between Nuremberg and Stuttgart, in the state of Baden Württemberg, in the municipality of Kreßberg. This municipality consists of 33 separate villages and counts less than four thousand inhabitants (December 2015). The community was founded on December 2010, after many years of intensively work, when the twenty founders decided to purchase the village of Tempelhof, nowadays, after 7 years it counts 120 people: 90 adults and 30 children. The community is based on the principles of ecological, economical e social sustainability.

The village consists of 30 hectares of land, of which 4 represent the core of the village with the living buildings and the common spaces and the 26 remaining are agricultural land.

The community since its beginning adopted the principles of organic farming in their agricultural land. The community pursues deeply these principles with the following actions:

- saving yearly the seeds and sowing them in their own nursery the next year;
- the fertility of the soil is kept by the spread of manure composted with the kitchen and farm waste;
- all the food produced is used inside the community or sold in the neighbour villages;
- animals are feed with cereals made in the farm.

According to Hornstein (2016) the area in which the sampling took place is a sub mountain area, 470 meters above sea level, characterized by vertisol. The main features of this soils are a vertic horizon lower than 100 cm from the surface, a clay content higher than 30%, shrink-swell cracks that starts at the soil surface and extend to the vertic horizon, FAO WRB (2014).

The climate of the area could be described as continental humid, with cold snowy winters and dry warm summers, the mean annual rainfall is around 800 mm. The mean annual temperature is 7,8°C. The trends of the maximum and minimum temperature for the year 2016 are reported in Figg. 1 and 2. The 2016 precipitations are described in Fig. 3.

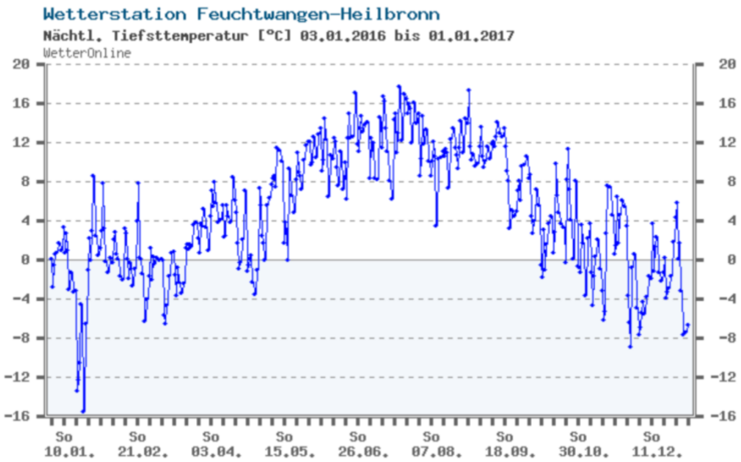

Fig. 1 Yearly minimum temperature.

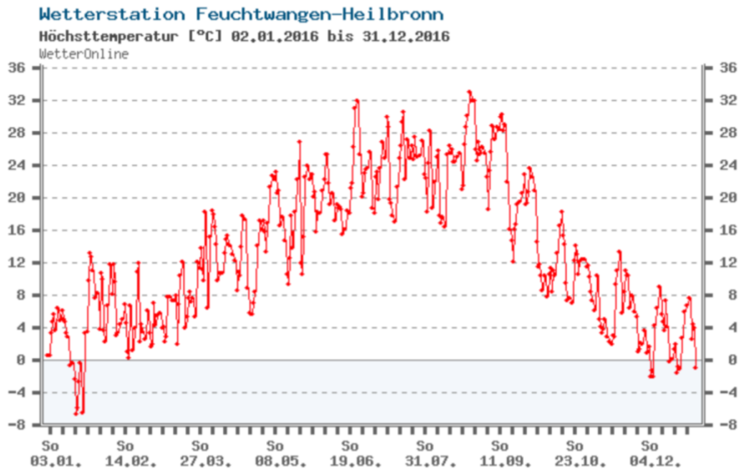

Fig. 2 Yearly maximum temperature.

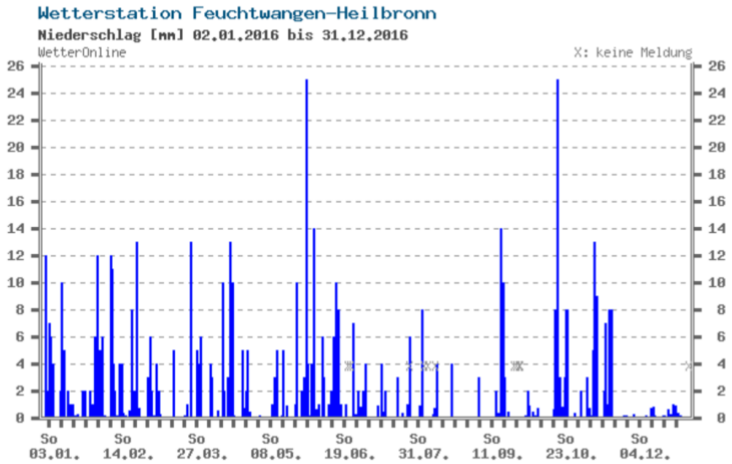

Fig. 3 Yearly rainfall.

2.2 Soil sampling

The soil cores were taken from 11 different fields, 9 of them belong to the community and 2 belong to the neighbours (Fig. 4). The number of samples for each field is correlated to the dimension of the field and varies between 4, Gewächshaus, and 8, Waldgarten. For every sample were taken 2 cores at different depths 0-30 cm, 30-60 cm, then once in the laboratory the cores were split in three sub-samples: 0-10 cm, 10-30 cm, 30-50 cm.

Soil samples (207) were collected from 11 different fields with different land-use:

- 2 are managed with conventional farming with open field crops (Rotbach Kontrolle - R0; Tempelfeld Kontrolle - T0);
- 1 is permanent grassland (Vorderes Grünland - Z);
- 3 are used to grow vegetables with high fertilizer input (Market Garden South - MS, Market Garden North - MN and Gewäschshaus - G3);
- 4 in rotation are used to grow cereals, vegetables or cover crops (Rotbach 1 - R1; Tempelfeld 1, 2 and 3 - T1 - T2 - T3);
- 1 is managed partially with permaculture technic partially as permanent grassland (Waldgarten - WG).

Fig. 4 The map of the site where the experiment took place, in red the border of the community of Schloss Tempelhof, in yellow the border of the 11 fields.

To sample the soil cores was used a powered soil sampler. The sampler machine is composed by a burst engine and a steel tube (Fig.5). The rotation of the engine allows the steel tube to penetrate the soil. For every sample a plastic tube was inserted inside the steel tube (Fig. 6). This enabled to maintain the profile of soil unchanged and to store easily the samples once collected. After the sampling the cores were stored at 4°C and sieved.

Fig. 5 Powered soil sampler during the sampling campaign.

Fig. 6 Steel and inner plastic tube after the collection of one sample.

2.3 Crop rotation and fertilization

In accordance to the organic farming principles, the article 12 from the law EC No 834/2007 prompts the crop rotation for the maintenance of soil fertility and the reduction of pathogens. The principle requires, with some exceptions, three-year rotation of which one must be a cover crop or a plant from the *Fabaceae* family. In Table 1 the crop rotation for each field in the last three years is described. The complexity of the rotation inside the community respond to the principle of long term sustainability and increase of biodiversity. All the cover crops are made of a mixture of seed that includes plants from different families including *Fabaceae* known as nitrogen-fixing plants. The neighbour fields on the other side have short rotation without nitrogen-fixing plants. The community fertilize the fields with compost derived from animal manure and farm and kitchen wastes composted for 6-12 months, in contrast the neighbours make use of chemical fertilizers (Tab. 1).

Table 1 Crop rotation field by field in the last 3 years; fertilizers employed in the different fields

SITE	CROP ROTATION			FERTILIZATION
	2014	**2015**	**2016**	
1 - R0	wheat	corn	wheat	chemical
2 - R1	vegetable - covercrop	oat - vegetable	rye peas - covercrop	-
3 - MN	covercrop - rye and peas	covercrop	potatoes	compost 500 m^3 ha^{-1}
4 - MS	covercrop - rye and peas	covercrop	pumpkins	compost 500 m^3 ha^{-1}
5 - G3	vegetable	vegetable	vegetable	compost 500 m^3 ha^{-1}
6 - T0	wheat	corn	wheat	chemical
7 - T1	spelt	oat and peas covercrop	hay	-
8 - T2	spelt - covercrop	vegetable - covercrop	rye and peas	-
9 - T3	spelt	vegetable - covercrop	vegetable	compost 100 m^3 ha^{-1}
10 - Z	hay	hay	hay	-
11 - WG	hay	hay	hay	-

2.4 Soil management

In the fields Rotbach 1 - R1 and Tempelfeld 1, 2 and 3 - T1 - T2 - T3 the agricultural practices are connected to the crop rotation: the rotary hoe is used to plough in the cover crops, then the soil is aerated with a ripper and prepared with a power harrow to host the plants, the third year the soil is prepared for cereals with the harrow. Before planting the soil is spread with approximately 100 m^3 ha^{-1} of farm-made compost. Weed are controlled mechanically or using thermal weed control.

In the fields Market Garden South - MS, Market Garden North - MN and Gewäschshaus - G3 the soil is aerated with a deep ripper and prepared with a cultivator, the cover crops are ploughed in with a rotary hoe. In these three fields the community use the technique of market garden that consists to grow consociation of plants in beds using high amount of compost: 500 m^3 ha^{-1}. Weed control is made by hand, hoes and thermal weed control.

In the fields Vorderes Grünland - Z and Waldgarten - WG the grass is cut and harvested 2-4 times per year.

The fields Rotbach Kontrolle - R0 and Tempelfeld Kontrolle - T0, managed with conventional practices, are mouldboard plowed every year. Before the sowing the soil is refined with a power harrow. The weeds are controlled with herbicides.

2.5 Sieving and homogenization of the samples

Standard methodology foresees to sieve the soil samples in order to homogenize them and separate foreign materials such as roots and stones with the use of 2 millimetres' sieves. In this case this practice was not possible due to the high content of clay. To homogenize the samples, we used a 4 millimetres' metal sieve as shown in figure 7.

Fig. 7 Sieving and homogenization procedure with 4 mm metal sieve.

2.6 Soil Dry matter

The soil dry matter is a measurement of the mass of soil when completely dried. This is an important factor since it is the base for many other chemical and biological experiments. In this case, soil dry matter was used in the calculations of bulk density and chloroform fumigation extraction. Soil dry matter was measured drying 10g of soil in a 105°C oven for 24 hours, every sample was placed in a paper envelop, labelled and weighted before and after drying. For every sample, 3 blanks were measured to deduct the weight of envelops from the weight of the samples. To calculate the soil dry matter the following formula was used:

Dry matter (%): Dry sample weight / Wet sample weight *100

2.7 Water holding capacity

The water holding capacity (WHC) is the amount of water held in the soil after excess water has drained and the rate of downward movement has decreased. To calculate the WHC glass tubes with porous membrane on the bottom were used. The procedure consists in the measuring the weight of the glasses dry and with the wet bottom. These have been filled with 10g of soil, then the samples have been soaked for 4 hours. Once the excess of water has leached they have been weighted and then dried in 105°C oven for 24 hours. After the drying the glasses have been weighted again to calculate the WHC:

*WHC (%) = (saturated soil – soil after drying) / soil after drying * 100*

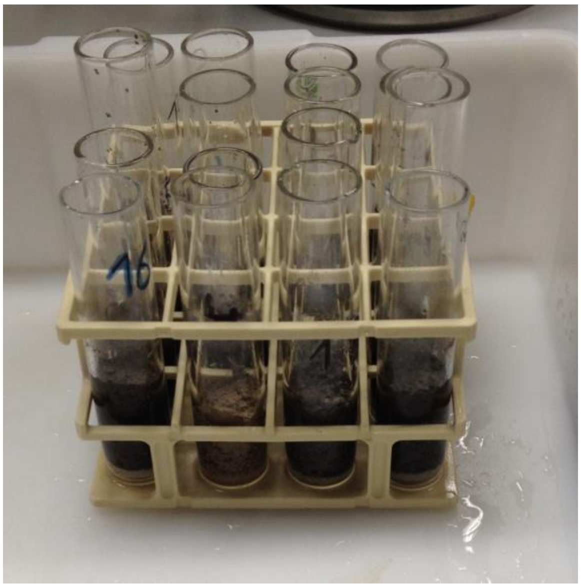

Fig. 8 Detail of the measuring of WHC

2.8 Bulk density

The bulk density is a property of powders, granules, and other ‘divided’ solids, especially used in references to mineral components or other masses of corpuscular or particulate matter. It is defined as the mass of many particles of the material divided by the total volume they occupy. The total volume includes also inter-particle void volume and internal pore volume. Bulk density it is not an intrinsic property of a material but depends on how it is handled. In the case of soils the bulk density depends greatly on the mineral make up and the degree of compaction. The bulk density could be calculated on dry or wet basis, in this experiment was used bulk density calculated on dry soils. To determinate the bulk density the following formula was used:

$$\rho = Mass / Volume$$

2.9 Microbial biomass

The carbon and nitrogen content in microbial biomass was estimated by chloroform fumigation-extraction (CFE) (Brookes et al.,1985; Vance et al., 1987). A sub-sample of 20g was taken from the each of 207 sieved samples, adjusted at 50% of WHC and divided in 2 portions of 10 g. One portion was fumigated at 25°C for 24 hours with 25ml of CH_3Cl in a desiccator. With a vacuum line the air was extracted. This operation make the CH_3Cl boiling and saturates the atmosphere inside the desiccator. The second portion of soil, was used for non-fumigated samples. Fumigated and non-fumigated samples were extracted for 40 min with 40ml 0,5M K_2SO_4 by horizontal shaking at 200 rev min^{-1} and filtered with hw3, Sartorius Stedim Biotech, Göttingen, Germany. Organic C and total N in the extract were measured via infrared and electrochemical detention, after combustion at 800°C using a multi N/C 2100S automatic analyser (Analytik Jena, Jena, Germany). Organic C is measured as CO_2 by nondispersive infrared sensor (NDIR) after combustion at 800°C. The NDIR is a spectroscopic sensor used as a gas detector. The main components of an NDIR are an infrared source, a sample chamber and an infrared detector. The IR light is directed through the sample chamber towards the detector, in parallel, there is another chamber with an enclosed reference gas. Then according to the Beer-Lambert law, that relates the attenuation of light, absorbance, to the properties of the material through the light is travelling, the detector can determine the gas concentration. The detector has an optical filter in front of it that eliminates all light except the wavelength that the selected gas molecules can absorb. Total N bound in the extract is measured after reaction to NOx compounds by electro-chemical detection (ChD). Electrochemical gas sensors are amperometric fuel cells with two electrodes. The basic components are a working electrode, a counter electrode and an ion conductor in between them. When gas encounters the working electrode, occur the oxidation of the gas. The reaction produces an electric current. The electrical output is proportionated to amount of N present in the solution. To calculate the Microbial Biomass C the following formula was used:

$$C_{mic}\ (\mu g\ C\ g^{-1}\ soil) = E_c / k_{EC},$$

where EC = (organic C extracted from fumigated soil) – (organic C extracted from non-fumigated soil) and k_{EC} = 0.45 (Wu et al., 1990)

$$N_{mic}\ (\mu g\ N\ g^{-1}\ soil) = E_N / k_{EN},$$

where EN = (total N extracted from fumigated soil) – (total N extracted from non-fumigated soil) and kEN = 0.54 (Brookes et al., 1985).

3. Results

The results of the dry matter and water holding capacity as they represent a preliminary step for the main analysis are shown in appendix A and B.

Soil bulk density was measured in two ways: divided in the three depth 0-10, 10-30 and 30-50 cm and for the whole core (0-50 cm).

Soil bulk density calculated by depth showed lower values in the top soil than deeper layers in 9 sites of 11, exceptions were found in Gewäschshaus - G3 and Tempelfeld 1 - T1 where in the middle depth higher values than the deepest were found (Tab. 2). In the first ten cm, the bulk density ranged from 0,86 gr cm^{-3} to 1,16 gr cm^{-3}, lowest values were found in permanent grassland sites (WG and Z) and in Gewäschshaus. In the middle depth, the BD varied from 1,06 gr cm^{-3} to 1,39 gr cm^{-3} minor values were found in the sites Rotbach 0 - R0, managed with conventional practices and Vorderes Grünland - Z, permanent grassland. In the deepest profundity analysed lowest BD were found in R0, G3 and T1 (1,14 - 1,18 gr cm^{-3}).

Bulk density calculated in the whole cores 0-50 cm varied from 1,06 gr cm^{-3} in the field Vorderes Grünland - Z to 1,28 gr cm^{-3} in the field Rotbach 1 - R1 (Tab. 3).

Table 2 Bulk density and coefficient of variation by site and depth

SITE	**Bulk density (gr cm^{-3}) ± CV (%)**		
Depth	**0-10 cm**	**10-30 cm**	**30-50 cm**
1 - R0	1,00 ± 14	1,06 ± 6	1,14 ± 13
2 - R1	1,01 ± 4	1,23 ± 5	1,61 ± 11
3 - MN	1,01 ± 9	1,27 ± 6	1,37 ± 17
4 - MS	1,11 ± 14	1,19 ± 9	1,38 ± 10
5 - G3	0,94 ± 22	1,25 ± 8	1,18 ± 34
6 - T0	1,16 ± 9	1,31 ± 9	1,44 ± 19
7 - T1	1,06 ± 11	1,39 ± 5	1,18 ± 13
8 - T2	1,16 ± 8	1,21 ± 7	1,34 ± 9
9 - T3	0,93 ± 6	1,14 ± 12	1,24 ± 10
10 - Z	0,79 ± 17	1,06 ± 7	1,33 ± 5
11 - WG	0,86 ± 15	1,13 ± 14	1,40 ± 9

Soil microbial biomass carbon and nitrogen was calculated in two ways: the amount of microbial biomass per hectare, considering the first 30 centimeters of soil, and as micrograms per gram of soil in three different depths 0-10, 10-30 and 30-50 cm.

The amount of microbial biomass carbon, estimated per hectare, ranged from 822 kg ha^{-1} in Rotbach 0 - R0, to 2813 kg ha^{-1} measured in Waldgarten. Soil microbial biomass nitrogen varied from 148 kg ha^{-1} in Tempelfeld 0 - T0, to 496 kg ha^{-1} in Waldgarten. In both cases (MBC and MBN) the land use showed a great influence on the microbial biomass. Sites with less soil disturbance such as permanent grassland, WG and Z, had the highest amount of microbial biomass C and N. The elevated amount of organic fertilizers used with the Market Garden technique, G3, MN, MS revealed a pronounced effect on the presence of microbial biomass both in MBC and MBN. In both analysis, their amount collocated between permanent grassland and open field crops. The sites R1, T1, T2, T3, managed with organic agriculture within the community, and in the neighbors' fields R0 and T0, managed with conventional techniques, showed the lowest amount of microbial biomass compared to the others (Tab. 3).

Table 3 Bulk density and stocks of microbial C and N in soil of eleven sites in Tempelhof

SITE	Bulk density gr cm^{-3} ± CV %	mic C kg ha^{-1}	mic N kg ha^{-1}
1 - R0	1,07 ± 12	822	183
2 - R1	1,28 ± 22	997	206
3 - MN	1,22 ± 17	1560	323
4 - MS	1,23 ± 14	1418	235
5 - G3	1,13 ± 24	1727	228
6 - T0	1,30 ± 16	1081	148
7 - T1	1,21 ± 15	1339	188
8 - T2	1,24 ± 10	929	187
9 - T3	1,10 ± 15	1217	176
10 - Z	1,06 ± 23	2085	271
11 - WG	1,13 ± 23	2813	496
CV (±%)	18	20	23
SEM (±mean)	0,02	31,6	4,9

The trend of microbial biomass C and N, evaluated in comparison to three different depths showed a higher amount in the topsoil decreasing with depth (Table 4, Fig. 9). This result is confirmed from many studies: Van Leeuwen et al., 2017, Ekelund et al., 2001, Taylor et al., 2002. An exception was found in the neighbour site Rotbach - R0, a possible explanation could be the land management such as the soil turning due to the plow practices.

Microbial biomass C (MBC) contents in the top soil were highest in permanent grassland (WG and Z) 2203 and 1494 $\mu g\ g^{-1}$ soil followed by fields managed with market garden techniques (MN, MS and G3) 892-1038 $\mu g\ g^{-1}$ soil, lowest contents were found on fields R1, T1, T2, T3 managed with organic farming practices (446-769 $\mu g\ g^{-1}$ soil) and in the fields R0, T0, managed with conventional techniques (386-522 $\mu g\ g^{-1}$ soil). In the depth between 10 and 30 centimetres the research found the same trend except for the field MS. MBC ranged from 332 $\mu g\ g^{-1}$ soil in T2 to 997 $\mu g\ g^{-1}$ soil in WG. On the deepest portion of soil analysed the highest amount of MBC was found in WG (456 $\mu g\ g^{-1}$ soil) and G3 (333 $\mu g\ g^{-1}$ soil). R0, Z and T0 showed medium contents of MBC (188-248 $\mu g\ g^{-1}$ soil). The fields MN, MS T1, T2, T3 showed the lowest contents compared to the previous mentioned (104-167 $\mu g\ g^{-1}$ soil).

The microbial biomass nitrogen (MBN) contents had a similar distribution at MBC in the topsoil with highest contents in the fields WG and Z (205-405 $\mu g\ g^{-1}$ soil) followed by sites managed with market garden techniques: MN, MS, G3 (148-183 $\mu g\ g^{-1}$ soil). Lowest contents were found in sites R1, T1, T2, T3 managed with organic farming and R0 and T0, managed with conventional practices (74-107 $\mu g\ g^{-1}$ soil). In the middle depth, the fields WG, MN and Z showed the highest microbial biomass nitrogen contents (104-165 $\mu g\ g^{-1}$ soil). R0, R1 and G3 revealed a medium MBN content (75-96 $\mu g\ g^{-1}$ soil). The lowest contents were found in the fields T0, T1, T2, T3, MS (49-69 $\mu g\ g^{-1}$ soil). The deepest soil portion analysed (30-50 cm) has a similar trend of MBC: the highest MBN was found in the fields WG, R0, G3, T0 (28-51 $\mu g\ g^{-1}$ soil). Medium values were found in sites MN, T2, MS (22-25 $\mu g\ g^{-1}$ soil). The fields R1, T1, T3 and Z revealed the lowest values (17-21 $\mu g\ g^{-1}$ soil) (Fig.10).

Microbial biomass C to N ratio in the first ten centimetres of oil ranged from 4,9 in MN, R0 and T2 to 7,4 Z. In the middle depth, 10-30 cm, were found similar results (4,6 R0, R1 - 8,4 G3). In the deepest part of soil analysed (30-50xm) a wider range of values were found: 4,9 T2 - 10,7 Z.

Table 4 Soil microbiological properties calculated in micrograms per gram of soil in three different depths.

SITE	mic C $\mu g\ g^{-1}$ soil			mic N $\mu g\ g^{-1}$ soil			mic C / mic N		
DEPTH (cm)	0-10	10-30	30-50	0-10	10-30	30-50	0-10	10-30	30-50
1 - R0	386	417	248	82	96	47	4,9	4,6	5,7
2 - R1	514	389	104	101	85	21	5,1	4,6	5,1
3 - MN	892	515	167	183	109	25	4,9	4,8	7
4 - MS	920	355	135	155	56	22	5,9	6,3	6,5
5 - G3	1038	626	333	148	75	40	7,3	8,4	10,1
6 - T0	522	372	188	74	49	28	7,1	8,2	6,6
7 - T1	695	436	158	96	62	20	7,3	7,3	7,8
8 - T2	446	336	115	90	68	24	4,9	5,0	4,9
9 - T3	769	449	130	107	69	17	7,3	6,5	7,6
10 - Z	1494	767	189	205	104	19	7,4	7,5	10,7
11 - WG	2203	997	456	405	165	51	5,4	6	8,9
CV (±%)	18	20	39	20	23	42	12	13	26
SEM (±mean)	66	26	13	10	4	2	0,15	0,2	0,33

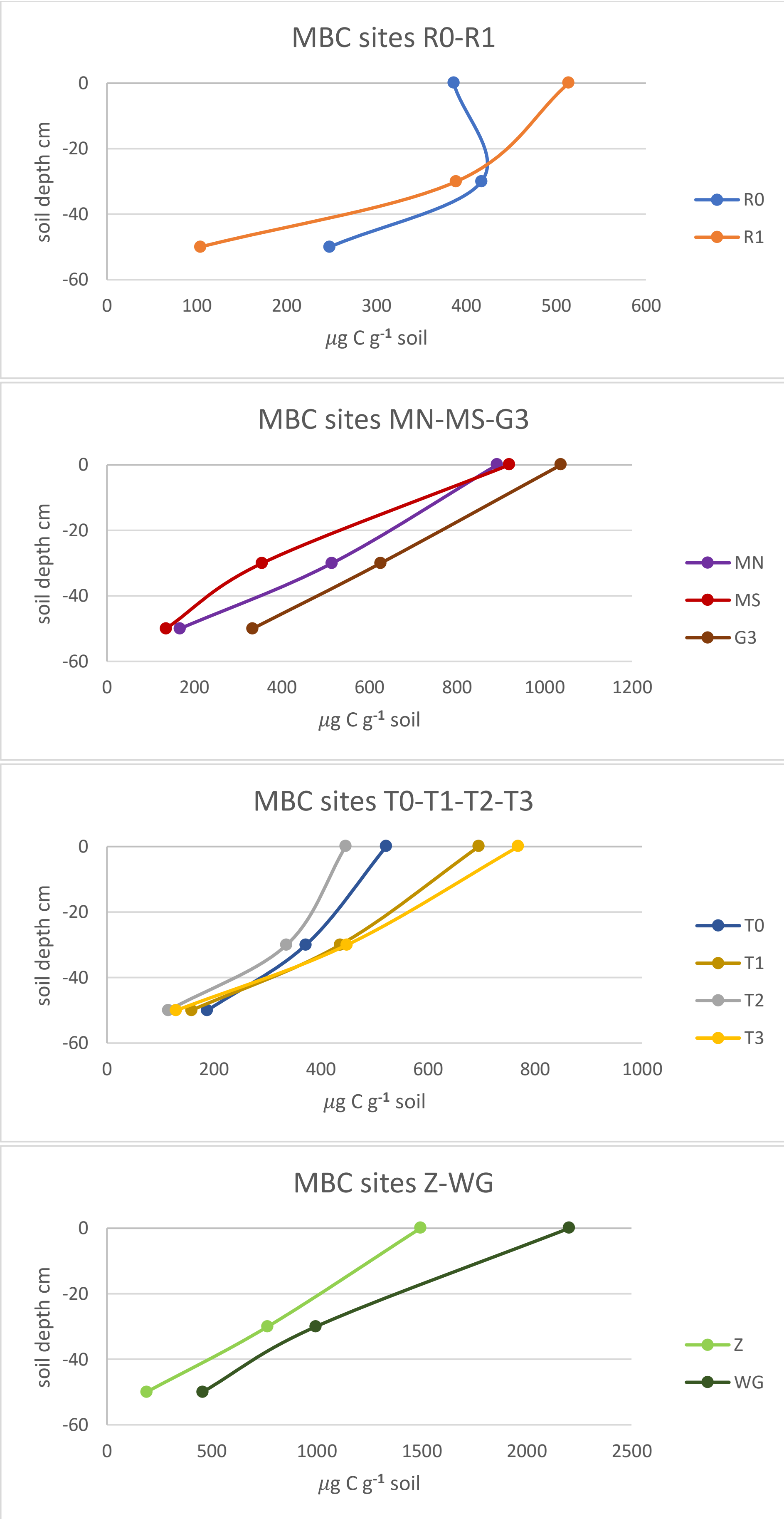

Fig. 9 Distribution of microbial biomass C in three depths in eleven sites.

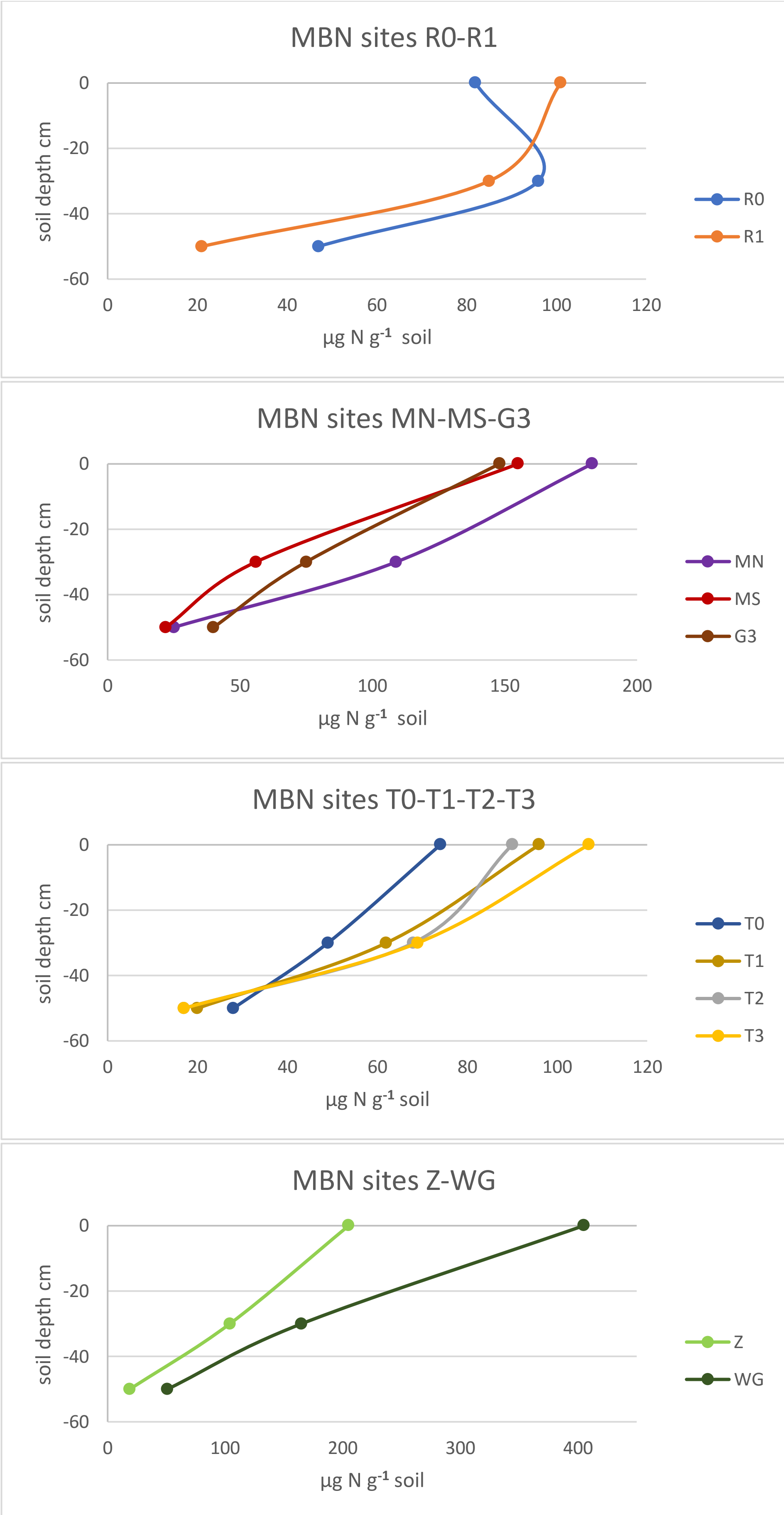

Fig. 10 Distribution of microbial biomass N in three depths in eleven sites.

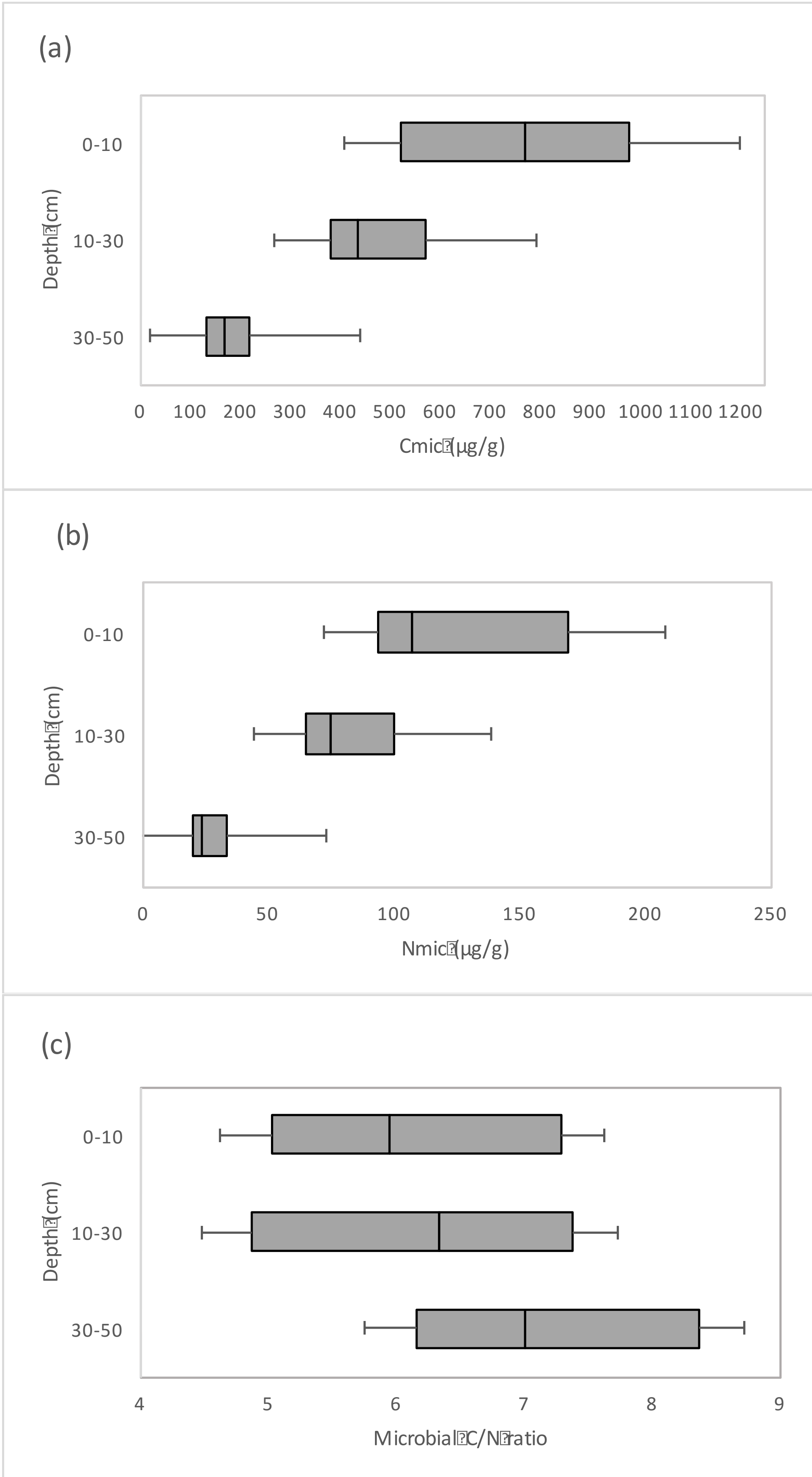

Fig. 11 Boxplot summarizing the C and N microbial biomass distribution and C/N ratio to depth, the whiskers represent the standard error, the solid line represents the median

4. Discussion

Bulk density is an important physical property of the soil, it is influenced by many factors as particle soil distribution, depth, organic matter content and compaction (Manrique and Jones, 1991). All the soil bulk density calculated in the eleven sites are inside the range found in literature for soils with high clay content (Rowell, 1994; Blume et al., 2016). Gewäschshaus - G3 showed high variability within the site and higher BD in the middle depth, a possible cause of this could be its building yard in 2016. This result suggests that the use of powered soil sampler is a useful alternative to hand soil samplers. It is a helpful instrument to sample a vast number of cores saving time and energy, on the other side it requires a team of at least two people to be used.

As found in literature (Van Leeuwen et al., 2017, Ekelund et al., 2001, Taylor et al., 2002) the microbial biomass was influenced by depth, pronounced differences were found in the top and medium depth, but only little variation was found in the deepest portion analysed. Environment condition as higher compaction and lower oxygen availability influences greatly the microbial growth.

The results obtained from the analysis of the microbial biomass calculated per hectare are comparable with the results obtained from the research made by Wentzel et al. (2015) in the same region. The data obtained indicates that the 4-mm size of the sieving could be an alternative to 2 mm sieving standard in presence of soil with high clay content.

Land use showed a great influence on the amount of microbial biomass content. In the microbial biomass C and N calculated per hectare significant differences between organic (MN - MS - G3 - R1 - T1 - T2 - T3) and conventional techniques (R0 - T0) were observed. Grassland WG and Z resulted statistically different from all the other techniques applied: market garden, open field organic and conventional practices. Significant difference was found between the same land use in organic (R1 - T1 - T2 - T3) and conventional practices (R0 - T0) only for microbial biomass N but not for C. The microbial biomass calculated in micrograms per gram of soil showed statistical difference between the different land use: grassland (WG and Z), market garden (MN - MS - G3), open field (R0 - R1 - T0 - T1 - T2 - T3). No statistical difference was found between open field practices organic (R1 -T1 - T2 - T3) and open field conventional practices (R0 - T0).

Microbial biomass C to N ratio in agricultural soils varies between 5 and 10, higher or lower values are rare (Jenkinson, 1988; Jörgensen and Muller, 1996). The results obtained from the research are inside the range above mentioned and most of them are near the average value found in literature of 6,7 (Jenkinson, 1988; Jörgensen and Muller, 1996). This represents a good results as higher values of microbial C to N ratio could reflect nutrient limitation. As shown by Hartman and Richardson (2013) the variations of C:N:P ratios of microbes are limited compared to wide differences observed in the soil. Microbial biomass respond proportionally to availability on nutrient on the soil: MBC is linear related to soil N pools. MBC increase proportionally to soil C pools only with low C content, high availability of soil C pools limit microbial biomass growth (Hartman and Richardson 2013). A more detailed research on these topics it would offer a wider understanding which are the limiting elements to plant and microbial growth.

5. Conclusion

The results obtained from the research activities are an interesting starting point on the wide topic of soil fertility associated to agricultural practices. They clearly show how agricultural practices influence the microbial biomass. The best conditions for the microbial biomass are connected to less soil disturbance such as in Vorderes Grünland and Waldgarten. A second important factor for the microbial biomass is the availability of soil organic matter as found in the field cultivated with the market garden technique.

Further analysis is desirable to appreciate more completely the results of the present research: a comparison of the results with chemical parameters such as pH, soil organic carbon, soil texture, cation exchange capacity and plant nutrients as N, P, K and S could offer a broader view of the status of the soil.

Appendix A

Dry matter

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
ROTBACH KONTROLLE	**1**	1	1	A	R0.1	486,52	2,95	-	6,49	5,52	85,05
	2	1	1	B	R0.1	1169,22	1,80	6,45	10,41	7,96	76,46
	3	1	1	C	R0.1	1449,46	21,81	0,94	7,9	6,54	82,78
	4	1	2	A	R0.2	581,50	9,44	0,11	8,18	7,00	85,57
	5	1	2	B	R0.2	1268,04	13,00	0,95	9,73	7,89	81,09
	6	1	2	C	R0.2	1595,17	41,13	-	8,87	7,51	84,67
	7	1	3	A	R0.3	611,30	7,00	0,06	9,09	7,70	84,71
	8	1	3	B	R0.3	1273,11	16,47	6,69	7,61	6,08	79,89
	9	1	3	C	R0.3	1466,92	31,93	0,16	8,73	7,32	83,85
	10	1	4	A	R0.4	669,21	7,50	0,12	7,53	6,39	84,86
	11	1	4	B	R0.4	1288,77	6,58	2,32	9,75	7,78	79,79
	12	1	4	C	R0.4	1112,77	15,39	1,82	8,92	7,59	85,09
	13	1	5	A	R0.5	651,43	5,12	-	8,3	7,07	85,18
	14	1	5	B	R0.5	1442,07	2,44	-	7,34	5,85	79,70
	15	1	5	C	R0.5	1621,74	0,62	0,08	8,54	7,17	83,96
	16	1	6	A	R0.6	700,13	7,18	-	8,37	7,20	86,02
	17	1	6	B	R0.6	1364,38	21,82	6,33	9,13	7,35	80,50
	18	1	6	C	R0.6	1186,86	5,79	-	8,42	7,08	84,09

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
ROTBACH 1	**19**	2	1	A	R1.1	652,46	14,82	4,41	10,77	9,06	84,12
	20	2	1	B	R1.1	1454,37	22,29	-	10,51	8,80	83,73
	21	2	1	C	R1.1	1751,41	64,85	0,09	10,52	8,99	85,46
	22	2	2	A	R1.2	586,79	8,35	0,68	10,48	8,96	85,50
	23	2	2	B	R1.2	1413,64	43,36	-	10,47	8,72	83,29
	24	2	2	C	R1.2	1848,01	22,82	-	10,65	8,89	83,47
	25	2	3	A	R1.3	627,16	16,87	3,61	10,75	9,24	85,95
	26	2	3	B	R1.3	1535,91	30,08	0,06	10,19	8,55	83,91
	27	2	3	C	R1.3	2209,28	25,65	-	10,43	8,70	83,41
	28	2	4	A	R1.4	620,33	12,27	4,16	10,53	8,95	85,00
	29	2	4	B	R1.4	1479,16	44,05	-	10,70	8,91	83,27
	30	2	4	C	R1.4	2166,61	92,76	0,10	10,81	9,19	85,01
	31	2	5	A	R1.5	617,61	7,95	6,45	10,78	9,45	87,66
	32	2	5	B	R1.5	1493,40	10,74	-	10,84	9,11	84,04
	33	2	5	C	R1.5	1958,96	93,96	-	10,50	9,06	86,29
	34	2	6	A	R1.6	597,86	25,08	2,30	10,85	9,35	86,18
	35	2	6	B	R1.6	1600,72	37,55	0,66	10,35	8,74	84,44
	36	2	6	C	R1.6	1758,96	73,58	0,31	10,42	8,84	84,84

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
MARKET GARDEN NORD	**37**	3	1	A	MN.1	598,69	2,25	1,72	10,25	8,78	85,66
	38	3	1	B	MN.1	1439,17	13,74	1,00	10,03	8,46	84,35
	39	3	1	C	MN.1	1758,99	9,47	0,04	10,80	9,29	86,02
	40	3	2	A	MN.2	617,85	0,65	2,03	10,07	8,35	82,92
	41	3	2	B	MN.2	1434,47	2,58	-	10,15	8,34	82,17
	42	3	2	C	MN.2	1693,57	15,33	-	10,70	9,22	86,17
	43	3	3	A	MN.3	595,40	1,56	1,87	10,02	9,98	99,60
	44	3	3	B	MN.3	1515,40	3,50	-	10,04	8,51	84,76
	45	3	3	C	MN.3	1856,14	35,90	0,09	10,04	8,51	84,76
	46	3	4	A	MN.4	663,52	1,49	0,65	10,37	8,84	85,25
	47	3	4	B	MN.4	1645,62	5,02	-	10,16	8,52	83,86
	48	3	4	C	MN.4	2322,55	-	-	10,19	8,54	83,81
	49	3	5	A	MN.5	601,88	8,65	1,69	10,3	8,76	85,05
	50	3	5	B	MN.5	1449,65	2,17	-	10,04	8,47	84,36
	51	3	5	C	MN.5	2290,63	7,06	-	10,12	8,74	86,36
	52	3	6	A	MN.6	659,11	4,12	1,23	10,12	8,43	83,30
	53	3	6	B	MN.6	1630,65	35,34	-	10,26	8,59	83,72
	54	3	6	C	MN.6	1578,95	16,61	-	10,91	9,40	86,16
	54.1	3	7	A	MN.7	551,93	9,78	3,15	10,19	8,48	83,22
	54.2	3	7	B	MN.7	1515,95	11,85	-	10,21	8,53	83,55
	54.3	3	7	C	MN.7	2227,3	11,73	-	10,96	9,16	83,58

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
MARKET GARDEN SUD	**55**	4	1	A	MS.1	665,62	31,58	5,93	10,10	7,82	77,43
	56	4	1	B	MS.1	1681,33	26,37	0,26	10,22	8,51	83,27
	57	4	1	C	MS.1	1746,76	8,33	-	10,19	8,76	85,97
	58	4	2	A	MS.2	801,55	4,89	2,18	10,10	7,99	79,11
	59	4	2	B	MS.2	1492,85	11,90	5,35	10,04	8,36	83,27
	60	4	2	C	MS.2	1796,22	0,19	-	10,41	8,73	83,86
	61	4	3	A	MS.3	704,31	4,67	4,21	10,20	7,67	75,20
	62	4	3	B	MS.3	1688,03	34,66	-	10,11	8,43	83,38
	63	4	3	C	MS.3	2076,61	15,80	-	10,05	8,35	83,08
	64	4	4	A	MS.4	665,23	2,96	0,60	10,07	7,73	76,76
	65	4	4	B	MS.4	1541,66	81,34	-	10,30	8,53	82,82
	66	4	4	C	MS.4	1728,46	60,30	-	10,34	8,73	84,43
	67	4	5	A	MS.5	675,07	4,22	7,43	10,06	7,40	73,56
	68	4	5	B	MS.5	1317,07	8,09	0,34	10,29	8,45	82,12
	69	4	5	C	MS.5	1673,26	2,16	0,07	10,10	8,71	86,24
	70	4	6	A	MS.6	576,11	2,26	1,81	10,05	7,66	76,22
	71	4	6	B	MS.6	1431,81	8,08	1,44	10,30	8,32	80,78
	72	4	6	C	MS.6	1591,10	20,50	3,36	10,02	8,42	84,03
	72.1	4	7	A	MS.7	666,42	4,86	0,72	10,18	7,90	77,60
	72.2	4	7	B	MS.7	1454,49	21,20	2,00	10,01	8,11	81,02
	72.3	4	7	C	MS.7	1780,09	18,00	-	10,35	8,66	83,67
	72.4	4	8	A	MS.8	761,34	7,10	1,06	10,13	7,86	77,59
	72.5	4	8	B	MS.8	1673,63	16,99	0,25	10,36	8,69	83,88
	72.6	4	8	C	MS.8	1819,78	3,22	-	10,25	8,95	87,32

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
GEWASCHSHAUS	**73**	5	1	A	G3.1	545,95	11,73	5,51	8,08	5,97	73,89
	74	5	1	B	G3.1	1524,92	5,91	1,55	6,03	4,87	80,76
	75	5	1	C	G3.1	1881,22	6,96	2,07	9,12	7,56	82,89
	76	5	2	A	G3.2	811,66	5,75	11,12	8,62	6,49	75,29
	77	5	2	B	G3.2	1652,77	18,99	1,80	8,10	6,50	80,25
	78	5	2	C	G3.2	1688,36	12,55	0,37	7,15	6,04	84,48
	79	5	3	A	G3.3	509,21	19,00	5,60	7,01	4,95	70,61
	80	5	3	B	G3.3	1486,21	13,99	0,88	6,42	5,19	80,84
	81	5	3	C	G3.3	1257,74	3,84	10,39	8,03	6,46	80,45
	82	5	4	A	G3.4	632,10	23,54	13,46	6,97	4,81	69,01
	83	5	4	B	G3.4	1332,90	6,90	0,70	9,44	7,56	80,08
	84	5	4	C	G3.4	1330,33	2,93	0,47	6,94	5,83	84,01

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
TEMPELFELD KONTROLLE	**91**	6	1	A	T0.1	655,19	2,42	0,29	10,15	7,91	77,93
	92	6	1	B	T0.1	1521,27	0,73	0,12	10,61	8,83	83,22
	93	6	1	C	T0.1	1679,84	109,75	-	10,86	8,72	80,29
	94	6	2	A	T0.2	641,03	18,86	-	10,63	8,82	82,97
	95	6	2	B	T0.2	1454,33	18,07	-	10,08	8,19	81,25
	96	6	2	C	T0.2	1557,63	110,54	0,70	10,35	8,78	84,83
	97	6	3	A	T0.3	692,19	14,20	0,40	10,84	9,27	85,52
	98	6	3	B	T0.3	1591,63	85,02	1,15	10,52	8,66	82,32
	99	6	3	C	T0.3	1456,22	140,60	0,26	10,50	9,42	89,71
	100	6	4	A	T0.4	703,84	5,46	1,15	10,09	8,65	85,73
	101	6	4	B	T0.4	1691,69	12,74	0,03	10,12	8,25	81,52
	102	6	4	C	T0.4	1780,59	47,22	1,75	10,66	9,10	85,37
	103	6	5	A	T0.5	736,08	8,48	0,01	10,37	8,94	86,21
	104	6	5	B	T0.5	1608,76	36,14	1,36	10,80	9,00	83,33
	105	6	5	C	T0.5	2227,43	114,63	0,34	10,66	8,98	84,24
	106	6	6	A	T0.6	778,63	11,62	0,50	10,27	8,86	86,27
	107	6	6	B	T0.6	1459,76	43,78	0,61	10,72	9,00	83,96
	108	6	6	C	T0.6	2174,29	136,30	-	10,35	8,80	85,02

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
TEMPELFELD 1	**109**	7	1	A	T1.1	641,83	2,73	4,71	11,03	9,28	84,13
	110	7	1	B	T1.1	1661,00	13,42	0,89	10,16	8,67	85,33
	111	7	1	C	T1.1	2319,81	31,03	0,20	10,21	8,72	85,41
	112	7	2	A	T1.2	492,76	6,10	9,50	10,99	9,72	88,44
	113	7	2	B	T1.2	1746,32	32,10	2,03	10,89	9,68	88,89
	114	7	2	C	T1.2	1745,84	60,80	0,00	11,03	9,48	85,95
	115	7	3	A	T1.3	675,21	4,64	1,21	10,52	9,22	87,64
	116	7	3	B	T1.3	1582,58	18,05	0,17	10,60	9,27	87,45
	117	7	3	C	T1.3	2074,87	77,54	0,00	10,37	8,75	84,38
	118	7	4	A	T1.4	684,64	11,61	1,19	10,38	9,14	88,05
	119	7	4	B	T1.4	1655,08	40,89	0,87	10,10	8,78	86,93
	120	7	4	C	T1.4	2059,40	59,26	0,00	10,77	9,13	84,77
	121	7	5	A	T1.5	647,17	9,50	0,21	10,46	8,94	85,47
	122	7	5	B	T1.5	1619,70	8,91	0,12	10,34	8,59	83,08
	123	7	5	C	T1.5	2193,50	109,32	0,04	10,22	8,95	87,57
	124	7	6	A	T1.6	598,42	2,80	1,91	10,79	9,32	86,38
	125	7	6	B	T1.6	1581,95	8,73	0,12	10,32	8,81	85,37
	126	7	6	C	T1.6	1813,25	3,67	0,03	10,44	8,57	82,09

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
TEMPELFELD 2	**127**	8	1	A	T2.1	729,58	9,26	0,58	10,40	9,04	86,92
	128	8	1	B	T2.1	1435,67	24,82	-	10,48	8,94	85,31
	129	8	1	C	T2.1	1770,25	39,52	-	10,05	8,51	84,68
	130	8	2	A	T2.2	727,47	16,59	5,16	10,25	8,87	86,54
	131	8	2	B	T2.2	1718,66	70,96	0,80	10,48	8,96	85,50
	132	8	2	C	T2.2	1847,98	95,35	-	10,81	9,21	85,20
	133	8	3	A	T2.3	585,35	6,47	5,28	10,87	9,59	88,22
	134	8	3	B	T2.3	1411,36	22,27	0,54	10,82	9,18	84,84
	135	8	3	C	T2.3	1792,92	19,20	0,20	10,42	8,84	84,84
	136	8	4	A	T2.4	743,74	5,20	0,51	10,80	8,98	83,15
	137	8	4	B	T2.4	1536,56	21,27	-	11,11	9,14	82,27
	138	8	4	C	T2.4	2113,31	6,94	-	11,11	9,10	81,91
	139	8	5	A	T2.5	733,50	5,20	0,22	10,32	8,48	82,17
	140	8	5	B	T2.5	1515,77	13,10	1,19	10,67	8,64	80,97
	141	8	5	C	T2.5	1514,52	4,22	-	10,29	8,79	85,42
	142	8	6	A	T2.6	705,86	22,68	0,38	10,63	8,94	84,10
	143	8	6	B	T2.6	1380,78	12,48	-	10,71	8,88	82,91
	144	8	6	C	T2.6	1463,62	7,20	-	10,54	8,82	83,68

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
TEMPELFELD 3	**145**	9	1	A	T3.1	523,72	4,75	7,13	10,01	8,28	82,72
	146	9	1	B	T3.1	1470,65	12,93	0,56	10,01	8,13	81,22
	147	9	1	C	T3.1	1559,41	-	-	10,12	8,38	82,81
	148	9	2	A	T3.2	582,40	3,52	1,73	10,02	8,13	81,14
	149	9	2	B	T3.2	1396,83	7,94	-	10,08	8,02	79,56
	150	9	2	C	T3.2	1906,37	10,01	0,29	10,06	8,27	82,21
	154	9	4	A	T3.4	622,85	15,82	3,10	10,12	8,41	83,10
	155	9	4	B	T3.4	1147,87	26,89		10,11	8,40	83,09
	156	9	4	C	T3.4	1589,42	46,12		10,09	8,49	84,14
	157	9	5	A	T3.5	593,87	7,02	2,67	10,02	8,32	83,03
	158	9	5	B	T3.5	1431,34	40,62	0,40	10,12	8,31	82,11
	159	9	5	C	T3.5	1607,25	-		10,01	8,44	84,32
	160	9	6	A	T3.6	640,12	8,03	1,69	10,02	8,55	85,33
	161	9	6	B	T3.6	1495,28	29,31		10,10	8,61	85,25
	162	9	6	C	T3.6	1717,32	35,88	0,84	10,04	8,48	84,46
	162.4	9	8	A	T3.8	612,08	7,42	0,94	10,03	8,52	84,95
	162.5	9	8	B	T3.8	1625,68	37,78	0,26	10,11	8,63	85,36
	162.6	9	8	C	T3.8	1754,86	261,89		10,06	8,56	85,09

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
VORDERES FELD GRUNLAND	**163**	10	1	A	Z.1	554,53	-	2,96	10,70	8,23	76,92
	164	10	1	B	Z.1	1432,96	26,04	0,29	10,65	8,53	80,09
	165	10	1	C	Z.1	1821,88	0,30	1,23	10,96	8,68	79,20
	166	10	2	A	Z.2	574,32	-	6,30	12,00	9,64	80,33
	167	10	2	B	Z.2	1401,38	20,70	1,28	11,52	9,28	80,56
	168	10	2	C	Z.2	1750,44	9,15	0,04	10,34	8,09	78,24
	169	10	3	A	Z.3	534,99	-	21,03	10,93	8,71	79,69
	170	10	3	B	Z.3	1359,03	18,92	2,27	11,11	9,13	82,18
	171	10	3	C	Z.3	1812,92	18,73	0,27	11,41	9,53	83,52
	172	10	4	A	Z.4	567,50	0,43	19,19	11,48	9,14	79,62
	173	10	4	B	Z.4	1440,02	10,43	-	11,83	9,76	82,50
	174	10	4	C	Z.4	1634,60	22,18	-	10,56	8,76	82,95
	175	10	5	A	Z.5	547,70	-	25,61	10,81	8,44	78,08
	176	10	5	B	Z.5	1218,48	1,23	3,54	10,89	8,72	80,07
	177	10	5	C	Z.5	1738,68	14,50	0,45	11,78	9,96	84,55
	178	10	6	A	Z.6	376,10	-	23,15	11,12	8,66	77,88
	179	10	6	B	Z.6	1206,00	1,00	0,68	10,65	8,28	77,75
	180	10	6	C	Z.6	1686,75	-	-	10,58	8,31	78,54

site name	sample number	site number	spot	depth	Tempelhof code	total weight [g]	weight stones [g]	organic fraction [g]	dry matter fresh [g]	dry matter dried [g]	dry matter %
WALDGARTEN	**181**	11	1	A	WG.1	493,75	-	7,16	11,19	8,36	74,71
	182	11	1	B	WG.1	1548,25	55,15	0,13	11,72	9,09	77,56
	183	11	1	C	WG.1	1717,02	11,92	0,24	11,84	9,66	81,59
	184	11	2	A	WG.2	529,47	-	17,32	10,56	7,94	75,19
	185	11	2	B	WG.2	1413,41	17,81	0,43	10,06	7,86	78,13
	186	11	2	C	WG.2	1805,15	0,96	0,06	11,07	9,08	82,02
	187	11	3	A	WG.3	557,30	5,50	13,21	10,47	8,15	77,84
	188	11	3	B	WG.3	1412,84	19,61	1,26	10,64	8,58	80,64
	189	11	3	C	WG.3	1770,08	2,91	0,05	10,76	8,71	80,95
	190	11	4	A	WG.4	492,89	0,22	19,31	10,98	8,16	74,32
	191	11	4	B	WG.4	1238,87	73,45	0,76	11,41	9,12	79,93
	192	11	4	C	WG.4	1519,08	-	-	10,21	8,46	82,86
	193	11	5	A	WG.5	539,69	-	8,93	10,07	7,79	77,36
	194	11	5	B	WG.5	1447,66	45,90	0,25	10,84	8,60	79,34
	195	11	5	C	WG.5	1711,05	7,99	-	10,72	8,61	80,32
	196	11	6	A	WG.6	544,31	49,30	5,00	11,02	7,59	68,87
	197	11	6	B	WG.6	1492,17	20,47	3,52	10,68	8,33	78,00
	198	11	6	C	WG.6	1811,01	0,59	-	11,91	9,35	78,51
	199	11	7	A	WG.7	509,41	-	31,60	11,18	8,15	72,90
	200	11	7	B	WG.7	1557,85	2,70	1,98	10,32	8,06	78,10
	201	11	7	C	WG.7	1705,51	1,41	0,51	11,68	9,61	82,28
	202	11	8	A	WG.8	670,41	0,27	8,07	12,68	8,94	70,50
	203	11	8	B	WG.8	1573,80	28,33	-	12,15	9,58	78,85
	204	11	8	C	WG.8	1856,87	2,95	-	11,61	9,28	79,93

Appendix B

Water holding capacity

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
ROTBACH KONTROLLE	1	30,22	30,55	10,85	46,94	39,34	9,12	15,94	18,97	7,27	79,71
	2	30,16	30,47	10,55	44,67	38,27	8,11	23,13	30,09	6,09	75,09
	3	28,66	28,91	10,69	44,38	37,49	8,83	17,40	21,06	6,64	75,20
	4	29,95	30,25	10,79	45,63	39,12	9,17	15,01	17,67	6,21	67,72
	5	31,01	31,32	10,33	45,36	39,35	8,34	19,26	23,86	5,70	68,35
	6	30,76	31,08	10,48	44,85	39,65	8,89	15,17	17,89	4,88	54,89
	7	31,13	31,37	10,57	46,07	40,12	8,99	14,95	17,58	5,71	63,52
	8	31,19	31,63	10,46	45,19	39,63	8,44	19,31	23,93	5,12	60,66
	9	35,28	35,76	9,24	48,58	42,98	7,70	16,67	20,00	5,12	66,49
	10	32,08	32,32	10,05	46,51	40,65	8,57	14,73	17,27	5,62	65,58
	11	35,22	35,68	9,99	48,86	43,22	8,00	19,92	24,88	5,18	64,75
	12	34,88	35,28	10,19	48,57	43,55	8,67	14,92	17,53	4,62	53,29
	13	30,65	30,94	10,03	45,45	39,27	8,62	14,06	16,36	5,89	68,33
	14	35,16	35,56	10,29	48,59	43,45	8,29	19,44	24,13	4,74	57,18
	15	34,69	35,16	10,06	48,34	43,16	8,47	15,81	18,77	4,71	55,61
	16	28,95	29,26	10,43	44,07	37,9	8,95	14,19	16,54	5,86	65,47
	17	34,65	34,96	10,49	48,47	43,03	8,38	20,11	25,18	5,13	61,22
	18	30,64	30,93	10,52	45,34	39,43	8,79	16,44	19,68	5,62	63,94

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
ROTBACH 1	19	21,81	22,14	10,46	36,5	30,48	8,67	17,11	20,65	5,69	65,63
	20	31,16	31,37	10,08	45,48	39,44	8,28	17,86	21,74	5,83	70,41
	21	20,74	20,94	10,29	34,88	29,44	8,70	15,45	18,28	5,24	60,23
	22	30,65	30,9	10,47	45,2	39,27	8,62	17,67	21,46	5,68	65,89
	23	30,27	30,53	10,52	44,76	38,85	8,58	18,44	22,61	5,65	65,85
	24	30,25	30,57	10,31	44,77	38,74	8,49	17,65	21,44	5,71	67,26
	25	31,19	31,49	10,65	46,43	40,19	9,00	15,49	18,33	5,94	66,00
	26	32,07	32,26	10,12	46,13	40,42	8,35	17,49	21,20	5,52	66,11
	27	24,14	24,42	10,63	38,83	32,89	8,75	17,69	21,49	5,66	64,69
	28	35,15	35,52	10,37	50,68	43,85	8,70	16,10	19,20	6,46	74,25
	29	35,28	35,69	10,04	49,73	43,52	8,24	17,93	21,84	5,80	70,39
	30	35,23	35,64	10,40	49,66	43,92	8,69	16,44	19,68	5,33	61,33
	31	35,21	35,64	10,38	50,39	44,27	9,06	12,72	14,57	5,69	62,80
	32	34,86	35,27	10,16	49,65	43,28	8,42	17,13	20,67	5,96	70,78
	33	30,08	30,37	10,66	44,39	39,16	9,08	14,82	17,40	4,94	54,41
	34	30,27	30,46	10,13	44,57	38,9	8,63	14,81	17,38	5,48	63,50
	35	34,97	35,26	10,10	49,27	43,39	8,42	16,63	19,95	5,59	66,39
	36	34,87	35,09	10,11	48,64	43,34	8,47	16,22	19,36	5,08	59,98

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
MARKET GARDEN NORD	**37**	30,63	30,9	10,06	45,77	39,14	8,51	15,41	18,21	6,36	74,74
	38	34,73	35,17	10,00	49,47	43,05	8,32	16,80	20,19	5,98	71,88
	39	28,66	28,8	10,09	43,71	37,26	8,60	14,77	17,33	6,31	73,37
	40	30,16	30,53	10,03	44,89	38,31	8,15	18,74	23,07	6,21	76,20
	41	31	31,27	10,09	45,66	39,17	8,17	19,03	23,50	6,22	76,13
	42	34,87	35,1	10,08	49,07	43,45	8,58	14,88	17,48	5,39	62,82
	43	28,95	29,36	10,04	44,2	37,87	8,92	11,16	12,56	5,92	66,37
	44	35,27	35,78	10,10	49,93	43,7	8,43	16,53	19,81	5,72	67,85
	45	34,81	35,16	10,12	48,72	43,2	8,39	17,09	20,62	5,17	61,62
	46	30,36	30,55	10,10	44,56	38,79	8,43	16,53	19,81	5,58	66,19
	47	29,36	29,54	10,04	43,74	37,71	8,35	16,83	20,24	5,85	70,06
	48	34,82	35,02	10,05	48,75	43,11	8,29	17,51	21,23	5,44	65,62
	49	30,25	30,49	10,02	44,57	38,7	8,45	15,67	18,58	5,63	66,63
	50	35,3	35,53	10,02	49,51	43,5	8,20	18,16	22,20	5,78	70,49
	51	30,26	30,51	10,02	43,76	38,82	8,56	14,57	17,06	4,69	54,79
	52	35,25	35,68	10,02	49,75	43,41	8,16	18,56	22,79	5,91	72,43
	53	32,08	32,32	10,04	46,26	40,34	8,26	17,73	21,55	5,68	68,77
	54	34,68	35	10,07	48,54	43,33	8,65	14,10	16,42	4,89	56,53
	54.1	29,95	30,29	10,06	45,01	38,13	8,18	18,69	22,98	6,54	79,95
	54.2	24,98	25,18	10,04	39,71	33,26	8,28	17,53	21,26	6,25	75,48
	54.3	34,64	34,96	10,01	49,35	42,88	8,24	17,68	21,48	6,15	74,64

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
MARKET GARDEN SUD	**55**	31,24	31,65	10,03	45,63	38,89	7,65	23,73	31,11	6,33	82,75
	56	34,87	35,06	10,04	48,24	43,12	8,25	17,83	21,70	4,93	59,76
	57	29,87	30,2	10,06	44,04	38,42	8,55	15,01	17,66	5,29	61,87
	58	30,6	30,81	10,02	43,83	38,26	7,66	23,55	30,81	5,36	69,97
	59	30,26	30,48	10,02	43,68	38,49	8,23	17,86	21,75	4,97	60,39
	60	30,28	30,46	10,00	44,74	38,57	8,29	17,10	20,63	5,99	72,26
	61	35,17	35,58	10,05	49,15	42,33	7,16	28,76	40,36	6,41	89,53
	62	27,99	28,22	10,06	41,51	36,2	8,21	18,39	22,53	5,08	61,88
	63	35,22	35,6	10,04	49,44	43,48	8,26	17,73	21,55	5,58	67,55
	64	30,1	30,53	10,12	43,98	37,76	7,66	24,31	32,11	5,79	75,59
	65	35,22	35,68	10,04	49,12	43,39	8,17	18,63	22,89	5,27	64,50
	66	30,24	30,5	10,00	44,52	38,55	8,31	16,90	20,34	5,71	68,71
	67	34,82	35,14	10,05	47,86	41,95	7,13	29,05	40,95	5,59	78,40
	68	30,16	30,47	10,00	43,26	38,21	8,05	19,50	24,22	4,74	58,88
	69	35,27	35,71	10,11	49,38	43,88	8,61	14,84	17,42	5,06	58,77
	70	30,36	30,58	10,02	44,5	37,7	7,34	26,75	36,51	6,58	89,65
	71	28,65	28,81	10,08	42,23	36,64	7,99	20,73	26,16	5,43	67,96
	72	30,65	30,95	10,04	44,76	38,92	8,27	17,63	21,40	5,54	66,99
	72.1	34,84	35,22	10,04	48,81	42,53	7,69	23,41	30,56	5,90	76,72
	72.2	30,76	31,08	10,01	44,39	38,87	8,11	18,98	23,43	5,20	64,12
	72.3	28,95	29,37	10,02	43,38	37,23	8,28	17,37	21,01	5,73	69,20
	72.4	30,25	30,52	10,06	43,96	37,91	7,66	23,86	31,33	5,78	75,46
	72.5	29,36	29,59	10,04	42,82	37,61	8,25	17,83	21,70	4,98	60,36
	72.6	31,18	31,5	10,12	45,92	39,95	8,77	13,34	15,39	5,65	64,42

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
GEWASCHSHAUS	**73**	30,27	30,59	10,13	45,01	37,6	7,33	27,64	38,20	7,09	96,73
	74	29,88	30,15	10,15	45,28	38,04	8,16	19,61	24,39	6,97	85,42
	75	30,37	30,77	11,12	46,14	39,6	9,23	17,00	20,48	6,14	66,52
	76	15,26	15,41	10,18	28,94	22,75	7,49	26,42	35,91	6,04	80,64
	76	35,21	35,62	10,91	50,03	45,15	9,94	8,89	9,76	4,47	44,97
	77	34,97	35,34	10,93	50,29	43,71	8,74	20,04	25,06	6,21	71,05
	78	35,29	35,67	10,17	49,66	43,84	8,55	15,93	18,95	5,44	63,63
	79	34,83	35,13	10,21	50,88	42,17	7,34	28,11	39,10	8,41	114,58
	80	34,86	35,37	10,33	50,36	43,22	8,36	19,07	23,56	6,63	79,31
	81	30,1	30,43	10,02	45,13	38,15	8,05	19,66	24,47	6,65	82,61
	82	30,25	30,63	10,08	46,39	37,1	6,85	32,04	47,15	8,91	130,07
	83	29,37	29,67	10,02	44,21	37,41	8,04	19,76	24,63	6,50	80,85
	84	30,25	30,53	10,42	45,03	38,99	8,74	16,12	19,22	5,76	65,90

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
TEMPELFELD KONTROLLE	**91**	30,59	30,71	10,48	46,01	38,42	7,83	25,29	33,84	7,47	95,40
	92	23,86	24,16	10,07	38,84	31,43	7,57	24,83	33,03	7,11	93,92
	93	34,82	35,17	10,50	50,45	43,18	8,36	20,38	25,60	6,92	82,78
	94	29,37	29,65	10,05	43,96	37,6	8,23	18,11	22,11	6,08	73,88
	95	28,66	28,96	10,27	43,19	36,84	8,18	20,35	25,55	6,05	73,96
	96	30,16	30,5	10,17	44,82	38,69	8,53	16,13	19,23	5,79	67,88
	97	30,64	30,91	10,10	45,85	39,11	8,47	16,14	19,24	6,47	76,39
	98	30,25	30,52	10,15	44,93	38,45	8,20	19,21	23,78	6,21	75,73
	99	35,29	35,77	10,18	49,85	44,34	9,05	11,10	12,49	5,03	55,58
	100	30,76	31,09	10,36	46,12	39,57	8,81	14,96	17,59	6,22	70,60
	101	31,01	31,33	10,17	45,52	39,11	8,10	20,35	25,56	6,09	75,19
	102	34,83	35,16	9,96	49,32	43,26	8,43	15,36	18,15	5,73	67,97
	103	28,96	29,36	9,96	43,59	36,94	7,98	19,88	24,81	6,25	78,32
	104	29,94	30,32	10,04	44,15	38,24	8,30	17,33	20,96	5,53	66,63
	105	27,99	28,26	10,29	42,96	36,66	8,67	15,74	18,69	6,03	69,55
	106	29,87	30,15	10,65	44,89	38,97	9,10	14,55	17,03	5,64	61,98
	107	30,99	31,23	10,21	45,25	39,45	8,46	17,14	20,69	5,56	65,72
	108	34,74	35,19	10,00	49,61	43,18	8,44	15,60	18,48	5,98	70,85

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
TEMPELFELD 1	**109**	35,29	35,71	10,07	49,94	43,69	8,40	16,58	19,88	5,83	69,40
	110	35,20	35,66	10,10	50,09	43,79	8,59	14,95	17,58	5,84	67,99
	111	30,23	30,47	10,10	44,18	38,79	8,56	15,25	17,99	5,15	60,16
	112	29,86	30,21	10,07	44,46	38,77	8,91	11,52	13,02	5,34	59,93
	113	34,97	35,26	10,03	48,83	43,82	8,85	11,76	13,33	4,72	53,33
	114	30,06	30,37	10,10	45,07	38,67	8,61	14,75	17,31	6,09	70,73
	115	21,80	22,18	10,14	36,57	30,61	8,81	13,12	15,10	5,58	63,34
	116	29,94	30,3	10,05	44,67	38,67	8,73	13,13	15,12	5,64	64,60
	117	30,25	30,58	10,12	45,13	38,67	8,42	16,80	20,19	6,13	72,80
	118	27,98	28,23	10,05	42,50	36,74	8,76	12,84	14,73	5,51	62,90
	119	30,65	30,90	10,09	44,62	39,34	8,69	13,88	16,11	5,03	57,88
	120	20,73	20,92	10,10	34,75	29,13	8,40	16,83	20,24	5,43	64,64
	121	24,14	24,36	10,10	39,19	32,67	8,53	15,54	18,41	6,30	73,86
	122	30,76	31,03	10,09	45,12	38,98	8,22	18,53	22,75	5,87	71,41
	123	31,19	31,51	10,01	45,03	39,87	8,68	13,29	15,32	4,84	55,76
	124	31,00	31,27	10,08	45,79	39,60	8,60	14,68	17,21	5,92	68,84
	125	34,84	35,28	10,08	49,71	43,36	8,52	15,48	18,31	5,91	69,37
	126	31,15	31,28	10,10	46,24	39,29	8,14	19,41	24,08	6,82	83,78

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
TEMPELFELD 2	**127**	31,15	31,44	10,00	45,05	39,74	8,59	14,10	16,41	5,02	58,44
	128	30,63	30,89	10,12	45,20	39,17	8,54	15,61	18,50	5,77	67,56
	129	34,87	35,08	10,13	49,83	43,34	8,47	16,39	19,60	6,28	74,14
	130	35,28	35,71	10,13	50,28	43,97	8,69	14,22	16,57	5,88	67,66
	131	29,87	30,18	10,06	44,22	38,39	8,52	15,31	18,08	5,52	64,79
	132	34,82	35,07	10,09	48,88	43,28	8,46	16,15	19,27	5,35	63,24
	133	34,72	35,11	10,01	49,15	43,31	8,59	14,19	16,53	5,45	63,45
	134	31,00	31,27	10,07	45,30	39,5	8,50	15,59	18,47	5,53	65,06
	135	21,81	22,10	10,15	36,68	30,26	8,45	16,75	20,12	6,13	72,54
	136	31,23	31,60	10,17	45,99	39,54	8,31	18,29	22,38	6,08	73,16
	137	24,18	24,44	10,22	38,25	32,41	8,23	19,47	24,18	5,58	67,80
	138	30,98	31,28	10,14	45,64	39,20	8,22	18,93	23,36	6,14	74,70
	139	23,83	23,98	10,20	38,63	32,04	8,21	19,51	24,24	6,44	78,44
	140	27,91	28,32	10,30	42,13	36,12	8,21	20,29	25,46	5,60	68,21
	141	34,97	35,23	10,08	50,17	43,5	8,53	15,38	18,17	6,41	75,15
	142	20,72	20,92	10,27	35,10	29,26	8,54	16,85	20,26	5,64	66,04
	143	23,68	23,82	10,00	38,33	31,76	8,08	19,20	23,76	6,43	79,58
	144	15,26	15,47	10,10	29,96	23,55	8,29	17,92	21,83	6,20	74,79

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
TEMPELFELD 3	**145**	32,05	32,20	10,00	46,56	40,13	8,08	19,20	23,76	6,28	77,72
	146	31,97	31,25	10,06	45,24	38,98	7,01	30,32	43,51	6,98	99,57
	147	35,28	35,70	10,04	49,98	43,58	8,30	17,33	20,96	5,98	72,05
	148	24,12	24,35	10,01	38,92	32,13	8,01	19,98	24,97	6,56	81,90
	149	34,81	35,07	10,14	49,53	42,74	7,93	21,79	27,87	6,53	82,35
	150	34,72	35,07	10,04	49,71	42,93	8,21	18,23	22,29	6,43	78,32
	154	31,00	31,26	10,40	45,93	39,25	8,25	20,67	26,06	6,42	77,82
	155	31,16	31,38	10,00	45,97	39,30	8,14	18,60	22,85	6,45	79,24
	156	23,60	23,81	10,05	38,15	31,94	8,34	17,01	20,50	6,00	71,94
	157	20,73	20,90	10,08	35,63	28,93	8,20	18,65	22,93	6,53	79,63
	158	23,78	23,96	10,06	38,43	31,91	8,13	19,18	23,74	6,34	77,98
	159	34,97	35,23	10,03	48,83	43,27	8,30	17,25	20,84	5,30	63,86
	160	27,88	28,23	10,00	42,72	36,32	8,44	15,60	18,48	6,05	71,68
	161	21,80	22,15	10,05	36,39	30,23	8,43	16,12	19,22	5,81	68,92
	162	15,26	15,41	10,09	30,21	23,65	8,39	16,85	20,26	6,41	76,40
	162.4	35,14	35,50	10,08	49,96	43,64	8,50	15,67	18,59	5,96	70,12
	162.5	34,85	35,02	10,05	49,43	43,32	8,47	15,72	18,65	5,94	70,13
	162.6	34,83	35,22	10,15	49,55	43,21	8,38	17,44	21,12	5,95	71,00

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
VORDERES FELD GRUNLAND	**163**	30,20	30,40	10,00	45,47	37,60	7,40	26,00	35,14	7,67	103,65
	164	34,96	35,20	10,05	50,11	42,81	7,85	21,89	28,03	7,06	89,94
	165	31,28	31,44	10,02	45,35	38,96	7,68	23,35	30,47	6,23	81,12
	166	29,40	29,58	9,96	44,93	37,26	7,86	21,08	26,72	7,49	95,29
	167	30,34	30,49	10,01	44,99	38,21	7,87	21,38	27,19	6,63	84,24
	168	30,30	30,43	10,06	44,33	37,82	7,52	25,25	33,78	6,38	84,84
	169	31,17	31,38	10,01	46,88	38,86	7,69	23,18	30,17	7,81	101,56
	170	29,13	29,42	9,98	43,80	36,98	7,85	21,34	27,13	6,53	83,18
	171	30,72	30,89	10,01	44,18	38,73	8,01	19,98	24,97	5,28	65,92
	172	28,02	28,28	10,10	43,72	35,80	7,78	22,97	29,82	7,66	98,46
	173	30,67	30,83	10,02	44,93	38,66	7,99	20,26	25,41	6,11	76,47
	174	31,16	31,37	9,95	45,50	39,16	8,00	19,60	24,38	6,13	76,63
	175	30,32	30,56	10,04	45,92	37,91	7,59	24,40	32,28	7,77	102,37
	176	30,23	30,47	10,03	45,58	38,01	7,78	22,43	28,92	7,33	94,22
	177	35,35	35,58	10,14	49,81	43,41	8,06	20,51	25,81	6,17	76,55
	178	29,91	30,19	10,04	46,54	37,63	7,72	23,11	30,05	8,63	111,79
	179	30,30	30,46	10,00	45,81	37,84	7,54	24,60	32,63	7,81	103,58
	180	28,70	28,89	9,98	42,07	36,25	7,55	24,35	32,19	5,63	74,57

site name	sample number	dry weight of glass [g]	fresh weight of glass [g]	initial weight of soil [g]	weight of glass & soil after 24 h soaking [g]	oven-dry weight of glass & soil [g]	weight of oven-dry soil [g]	water content (relative to fresh weight) [%]	water content (relative to dry weight) [%]	absolute WHC of soil [g]	WHC of dry soil [%]
WALDGARTEN	**181**	30,78	31,06	10,01	46,62	38,04	7,26	27,47	37,88	8,30	114,33
	182	30,18	30,44	10,05	45,10	37,76	7,58	24,58	32,59	7,08	93,40
	183	28,66	28,84	9,99	43,9	36,57	7,91	20,82	26,30	7,15	90,39
	184	34,85	35,28	10,10	51,15	42,28	7,43	26,44	35,94	8,44	113,59
	185	30,99	31,28	10,00	45,97	38,52	7,53	24,70	32,80	7,16	95,09
	186	30,62	30,88	10,03	45,55	38,65	8,03	19,94	24,91	6,64	82,69
	187	31,19	31,45	10,10	47,46	38,90	7,71	23,66	31,00	8,30	107,65
	188	30,26	30,52	10,13	45,06	38,16	7,90	22,01	28,23	6,64	84,05
	189	30,07	30,45	10,08	45,23	38,06	7,99	20,73	26,16	6,79	84,98
	190	35,31	35,69	10,07	51,20	42,54	7,23	28,20	39,28	8,28	114,52
	191	30,24	30,45	10,02	44,90	38,09	7,85	21,66	27,64	6,60	84,08
	192	29,37	29,60	10,14	44,06	37,52	8,15	19,63	24,42	6,31	77,42
	193	35,19	35,64	10,05	51,59	42,80	7,61	24,28	32,06	8,34	109,59
	194	35,25	35,61	9,99	50,59	42,94	7,69	23,02	29,91	7,29	94,80
	195	28,98	29,32	10,06	44,17	36,77	7,79	22,56	29,14	7,06	90,63
	196	30,38	30,61	10,08	45,79	37,05	6,67	33,83	51,12	8,51	127,59
	197	31,24	31,66	10,11	45,29	38,81	7,57	25,12	33,55	6,06	80,05
	198	27,99	28,35	10,06	41,77	35,56	7,57	24,75	32,89	5,85	77,28
	199	30,27	30,53	10,07	46,36	37,37	7,10	29,49	41,83	8,73	122,96
	200	30,65	30,96	10,05	45,91	38,28	7,63	24,08	31,72	7,32	95,94
	201	30,25	30,48	10,08	44,9	38,47	8,22	18,45	22,63	6,20	75,43
	202	27,90	28,21	10,05	43,39	34,80	6,90	31,34	45,65	8,28	120,00
	203	34,87	35,11	10,20	48,86	42,73	7,86	22,94	29,77	5,89	74,94
	204	29,87	30,19	10,10	44,27	37,62	7,75	23,27	30,32	6,33	81,68

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