BODEN
ökologie analytik landschaft
TB UNTERFRAUNER GMBH

Geschäftsführer DI Hans Unterfrauner
Rochuspark, Erdbergstraße 10/33, A-1030 Wien
office: +43 676 3641030
mobil: +43 664 3890397
office@bodenoekologie.com
www.bodenoekologie.com

FN 430626z / Gerichtsstand Wien
UID: AT U69409936
Bankverbindung: Erste Bank Oesterreich
IBAN: AT41 2011 1826 6448 0200
BIC: GIBAATWWXXX

Customer:
Joe Bloggs

Ecological Basic Characterization

Sample:	1
Sampler:	Joe Bloggs
Position:	unknown
Climate:	unknown
Crop/Yield:	Winter Rapeseed 4 t/ha
Laboratory:	Water & Waste, LabNr. agr15-0590.1 / 2015

Results:

Light/medium-heavy soil, lime-free, pH-value$_{water}$ slightly alkaline, pH-value$_{KCl}$ slightly acidic, danger of acidification. Aggregate stability middle, electric conductivity very high/danger of washout, content of humus low, quality of humus beneficial.
Site very weak in terms of sorption, calcium- and magnesium-content on the sorption complex very low. Potential acid very high.
Lack of plant available substances (phosphorus, manganese, zinc, molybdenum).
Surplus of potassium, sulphur, iron.
Traces of potential toxic elements nickel, chrome, lead.

Measures:

Humus formation (leave straw on the field, green manure, catch crops, compost). Application of lime, gypsum and dolomite to improve and stabilize the acid system. Application of calcium (lime, gypsum), potassium and magnesium (dolomite) to optimize the sorption complex. Mobilizing the reserves of phosphorus und manganese, addition of zinc, molybdenum (if needed via leaf-application).

Vienna, 09.07.2015

Soil Characteristics

1

Table 1: Summary

Soil Characteristics, Depth 0 - 30 cm

	Parameter	Value	very low	low	favourable	high	very high	Remarks
Basic Parameters	Class of soil texture (KH)	42						light/medium heavy soil
	pH value KCl [-log H+]	6,5						weak acidic
	pH value H2O [-log H+]	7,4						weak alkaline
	Lime content CaCO3 [%]	0,0						unverifiable
	Substances in solution [ec, mS/cm]	1,1						washout
	Soil org. matt. content [%] = Corg * 1,724	1,5						green manure
	Soil organic matter quality [C/N]	13,4						N subsequent delivery from humus
	Soil organic matter quality [C/P]	48,1						favourable
	Soil organic matter quality [C/S]	100,0						narrow ratio
Sorption Complex	CEC pot [mmolc/kg]	55						pot sorption weak
	CEC act [mmolc/kg]	23						act very sorption weak
	Base saturation [BS % CECpot]	42						risk of acidification
	Ca on the magnet [%CECpot]	32,5						very low
	Mg on the magnet [%CECpot]	7,4						very low
	K on the magnet [%CECpot]	2,0						favourable
	Na on the magnet [%CECpot]	0,2						favourable
	Al on the magnet [%CECpot]	0,1						favourable
	NH4N on the magnet [%CECpot]	0,0						favourable
	Fe on the magnet [%CECpot]	0,0						favourable
	Mn on the magnet [%CECpot]	0,0						favourable
	H on the magnet [%CECpot]	0,3						actual acid low
	pot. Acid on the magnet [%CECpot]	57,6						very high

Melioration (Measures to increase / preserve Soil Fertility)

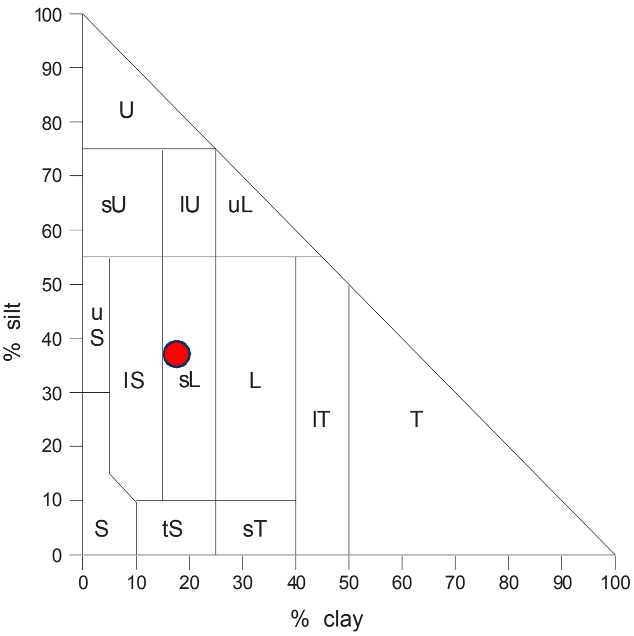
min.	Lime (CaCO3) kg/ha	2840	Dolomite (with 40% MgCO3) kg/ha	1820	Potassium (K) kg/ha organic or mineral	170
	Gypsum (CaSO4 * 2 H2O) kg/ha	350	Magnesium (Mg) kg/ha			
org.	Building of permanent humus kg/ha	54500	leave straw on the field		Catch crops	
			green manure		Compost	

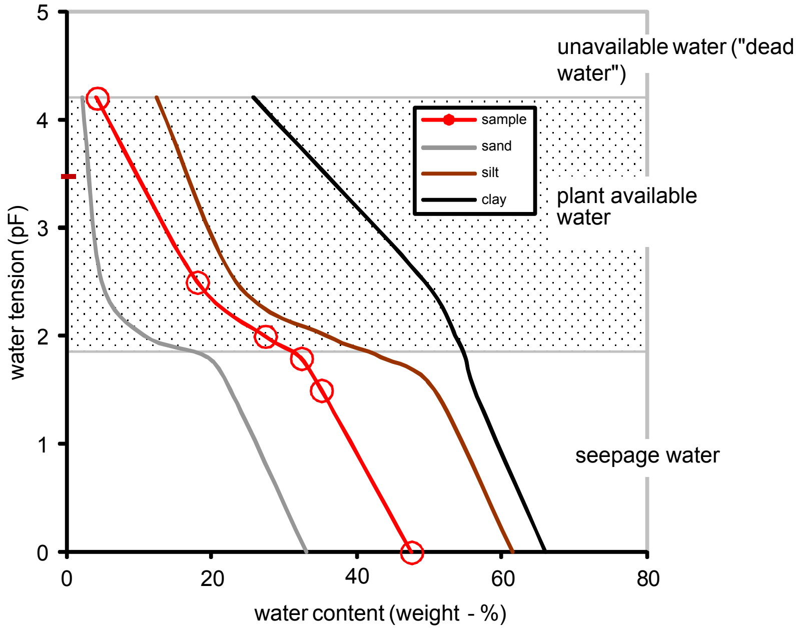
	Plant Nutrition	Value	very low	low	favourable	high	very high	Diff. 1) kg/ha	Assessment at the time of sampling	Reserve kg/ha
Mineralization-Potential	C org [kg/ha]	600							building humus	40000
	N org [kg/ha]	48							low reserves	3200
	P org [kg/ha]	12							high reserves	832
	S org [kg/ha]	6							medium reserves	400
Substance plant available at the time of sampling	Ca [kg/ha]	1535							sufficient	4900
	Mg [kg/ha]	220							sufficient	800
	K [kg/ha]	230							surplus	600
	P [kg/ha]	10						20	serious shortage	500
	NH4-N [kg/ha]	0,7						(20)	serious shortage	
	NO3-N [kg/ha]	130,3						(10)	sufficient	
	N min [kg/ha]	131,0						30	sufficient	
	SO4 [kg/ha]	164,0							surplus	
	Fe [kg/ha]	1,6							surplus	7100
	Mn [kg/ha]	0,04						1,60	serious shortage	1390
	Cu [kg/ha]	0,03							sufficient	30
	Zn [kg/ha]	0,00						1,60	serious shortage	30
	Mo [kg/ha]	0,00						0,18	serious shortage	0
	B [kg/ha]	0,32							sufficient	0
	Aluminium								no anomalies	
	pot. toxic substances								risk of contamination	

Mobilization:	**Phosphorus, Manganese**
Input:	**Zinc, Molybdenum**

[1] Difference of the needs of the plants during the whole vegetation period at the time of sampling. Crop: W Rape, Yield: 4 t/ha

Soil-physical Derivations

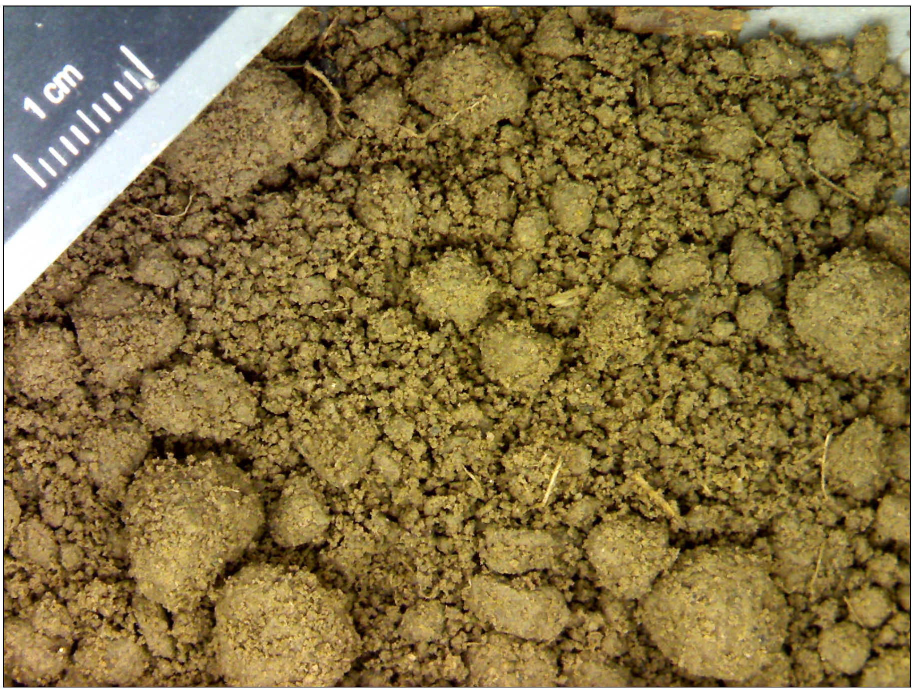




Austrian texture triangle OENorm L 1050

Water tension and water content

Source:Stefan Diringer (2010): Gibt es in der Bodenphysik Möglichkeiten Einzelparameter durch einen einzelnen Summenparameter zu charakterisieren? Scientific Diploma Thesis. Department of Geography and Regional Research, University of Vienna



Detailed picture of the sample

Basic Characteristics

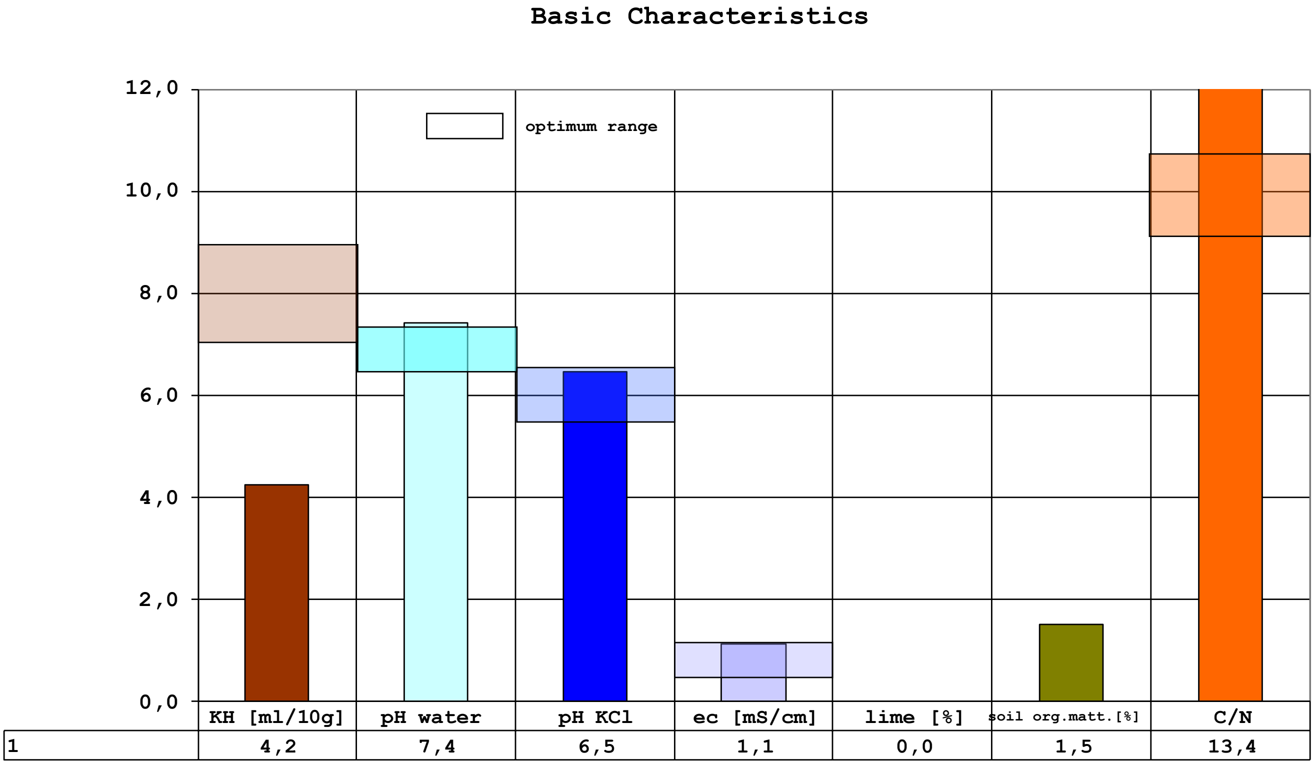


Figure 1: Basic characteristics of the soil

Class of Soil Texture/Soil Water Regime

The sandy/loamy **soil texture** determines a **light/medium-heavy** soil. Fully saturated the soil is able to hold back approx. 4,2 ml water per 10 g. This equals an amount of water of 840 m^3/ha and a depth of 30 cm. If fully saturated in winter/spring this is enough to outlast short droughts (early summer drought) without any damage.

The **pF-curve** in the section „Soil-physical Derivations“ shows, which suction tensions are predominant under which water contents in percent by weight. Below pF 1,8 the water is bound weakly (seepage water) and not plant available. Between pF 1,8 and 4,2 is the area of plant available water. Above pF 4,2 the water in the soil is already bond too strong, so the „forces“ of most of the cultivated crops are insufficient to get water out of the soil, the plants are wilting („wilting point“). The energetic „crucial point“ is pF 3,5. From this suction tension the plant needs more energy to get water out of the soil, than provided and stored by photosynthesis. If irrigation is an option it should start no later than suction tension 3,5 (marked red in the diagram).

To get a picture of the actual water tension take a representive soil sample. Weigh the sample in wet and dry condition, the difference in weight equals the water content. With the gauge reference (water content in %) and the pF-curve in the diagram you can deduce the suction tension directly.

Aggregate Stability

The aggregate stability is **middle**, after shaking the sample with water the supernatant liquid was slightly clouded. The clouding is based on suspended soil parts. This can lead to problems with the water- and air balance of the soil.

pH Value

The pH_{water} is in the slightly alkaline range **(7,4)**, in the neutral salt the ***pH***-value (KCl) is slightly acidic with **6,5**. The buffering system is in the range of the **exchange buffer**. The difference between the two pH-values allows conclusions about the biological activity of the soil. Differences between 0,5 und 1,5 pH-units have proved to be beneficial. The difference of 0,9 pH-units of the sample in hand is a hint for lively microorganism activity, relating to the acidic state of the sample.

Soil Solution

The **electric conductivity** represents the amount of salts in solution. The electric conductivity of the sample is **1,1 mS/cm** and lies considerably higher than the beneficial range (0,5 to 1) for the vegetation period. There is a danger of washout! ATTENTION: At the end of the growing season or during the dormant period lower values are favourable! The salts in solution (see also the water-soluble fraction on the analysis sheet) are important for plant nutrition (transpirational suction) and for aggregate stability. The site is very weak in terms of sorption. Already during smaller rainfall events the **washout** of elements from the soil solution can be expected. The application of easily soluble substances should only be performed in exceptional situations. Additionally the amount of the substance has to be adjusted to the stage of development of the crop. The following elements are responsible for the electric conductivity in the soil (all parameters see appendix):

Table 2: Composition of the soil solution, concentrations in mg/l

Nutrient	1
Ca	175
Mg	28
K	51
Na	7
NH_4-N	0
NO_3-N	85
P	0,30
SO_4	85
Cl	25
Al	0,0
Fe	0,0
Mn	0,00
B	0,14
Zn	0,00
Cu	0,02
Si	4,3
Ni	0,01
Cr	0,006
Pb	0,02

The soil solution is the most important medium for plant nutrition. Plant roots are only able to absorb solutes. The selectivity of the plant absorption for distinct nutrients is only working in an optimum range out of an "ideal solution". That's why the soil solution should hold an "ideal composition" of substance concentrations.

Potassium **(K)** is in solution in a beneficial concentration in proportion to magnesium (**Mg)** and calcium (**Ca)**. The Phosphorus (**P)** concentration is in an **optimum range.** The **supply with trace elements** is good, apart from iron (Fe), manganese (Mn) and zinc (Zn).

The ratio of **NO_3-N** to **NH_4-N** is shifted towards. NO_3-N. This is beneficial and indicates sufficient soil ventilation for nitrogen-oxidizing bacteria.

The concentration of sulphate (**SO_4**) is increased.

Traces of the potential toxic elements nickel (**Ni**), chrome (**Cr**), lead (**Pb**) were detected in the soil solution. The contamination source has to be spotted.

<u>Content of Soil organic Matter (humus)</u>

The ***content of soil organic matter is relatively low*** for a field site in this soil texture class and should be increased. To accomplish that the regular cultivation of green manuring crops is suitable.

Table 3: Content of soil organic matter and potential of mineralization

content of soil org.matt.	%	1,52	potential of mineralization	
quality of soil org.matt.	C:N	13,4	30 to 50	kg/ha
	C:P	48	5 to 15	kg/ha
	C:S	100	4 to 10	kg/ha

The **C/N** ratio of **13,4** is relatively narrow. The type of humus is mull. Under good weather conditions (temperature, moisture) the amounts of N, P and S (sulphur) specified in table 3 potentially can be mineralized during one growing season through microbiological processes. The mineralized nutrients can be absorbed by the plants and can contribute an important part to plant nutrition.

Sorption Complex

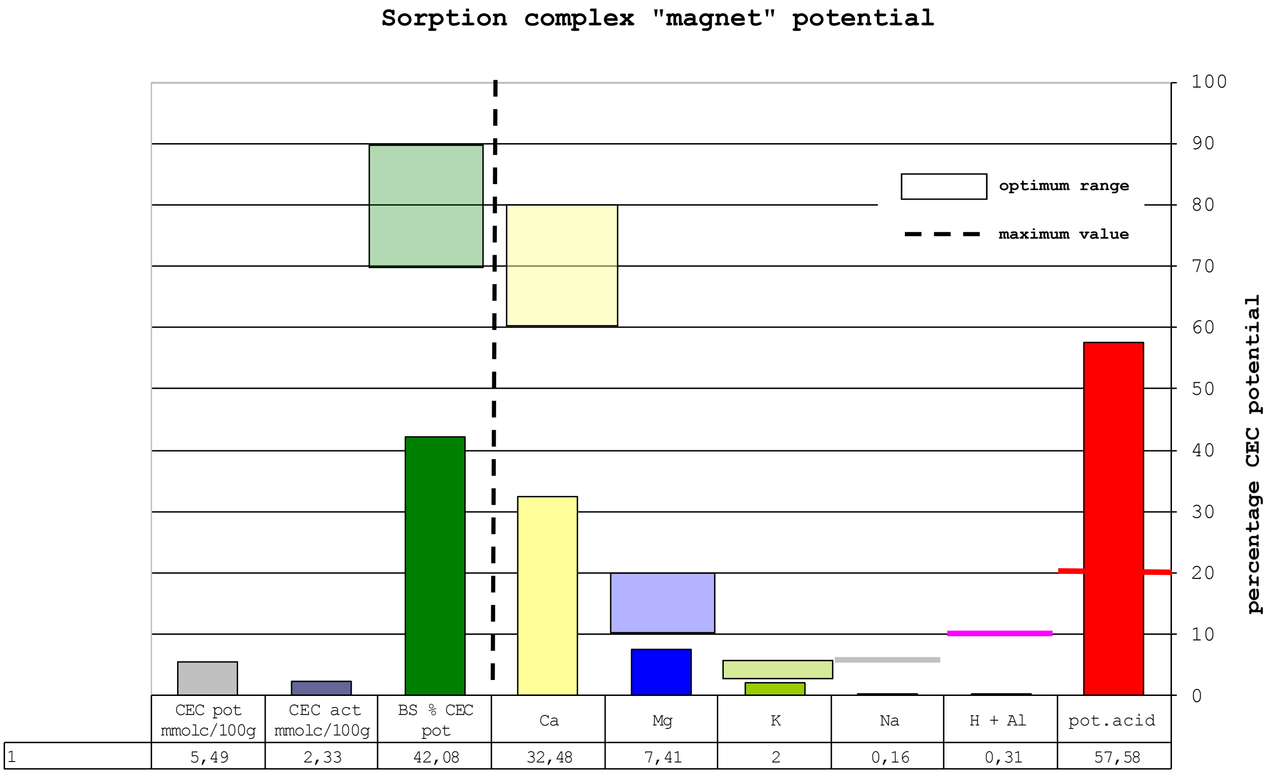


Figure 2: Composition of the sorption complex

Humus and clay particles are able to attach nutrients in the soil and prevent them from washout. These components in the soil are acting like „***magnets***“ because they have an electric charge. They are called the sorption complex/exchanger. The strength of the magnet, meaning the number of charges that are able to attach, is called exchange capacity (**CEC**).

The tested soil sample has a total magnet capacity (**CEC pot**) of **5,49 mmolc/100g.** This can be attributed to the humus and the clay minerals, oxides and hydroxides.
Currently **42%** of the total capacity is used, this corresponds to an actual capacity of **2,33 mmolc/100g (=CEC act)**! Presently the soil is **very weak** in terms of **sorption**.

The ***base saturation*** (**BS**) with **42%** is clearly beneath the wanted range (70-90%), the ability to buffer additional acid-inflows is moderately pronounced. There is a danger that the site gets **increasingly acidified** within a short period of time, the soil fertility is **at risk**. Additionally the „potential“ acid is very high (58%), the ability to buffer acids should be reinforced.

On sites with a pH_{KCl} < 7 a part of the sorption surface areas is blocked with „potential acid“. That's why the capacity of the magnets is declining (see the difference between CEC pot and CEC act). In these cases the exchangeable substances have to be related to the actual used part of the magnet, because that is the actual environmental situation for plant roots and microorganisms.

The occupancy of the magnet with nutrients is an important parameter for the assessment of soil fertility. Optimal conditions are present, if:

	Ca :	Mg :	K :	Na :	(H+Al)
TARGET:	**60-80**	**10-20**	**1,5-4**	**< 5**	**< 10**
1	76,6	17,5	4,7	0,4	0,7

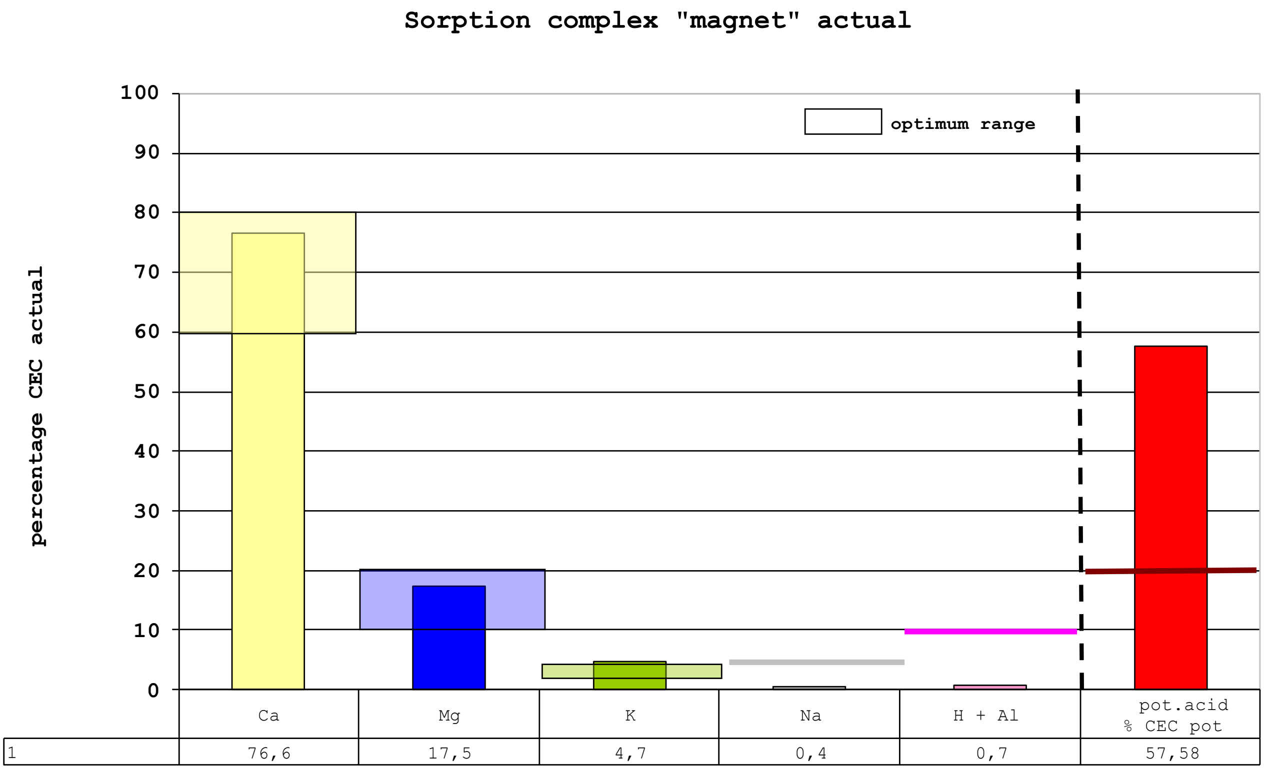


Figure 3: Composition of the actual sorption complex

The plant roots and the microorganisms find a **partly beneficial** distribution of substances on the **actual** used part of the **sorption complex** (**CEC act**).
The parts of **Ca** and **Mg** are located in the optimal range. **K** lies in surplus.

The part of **potential acid (pot. acid)** is very high. Potential acid is formed by the acid buffering beginning in the range of the exchange buffer. Acid is accumulated on the sorption complex, nutrients (Ca, Mg, K, Na, NH_4-N) are mobilized. The higher the acid-part gets, the „tighter“ the acid is fixed, increasingly bigger sections of the „magnet-areas“ get blocked, the potential of the site is declining in total.

To increase the Ca-content and to buffer a part of the potential acid the application of the substances, specified in the summary "melioration" (table 1), is recommended . All melioration calculations refer to the total capacity, because with that the potential acid is mobilized and neutralized.
It is important to apply all of the specified substances. Otherwise the beneficial distribution of the cations is influenced negatively.

Assessment of the Nutrients

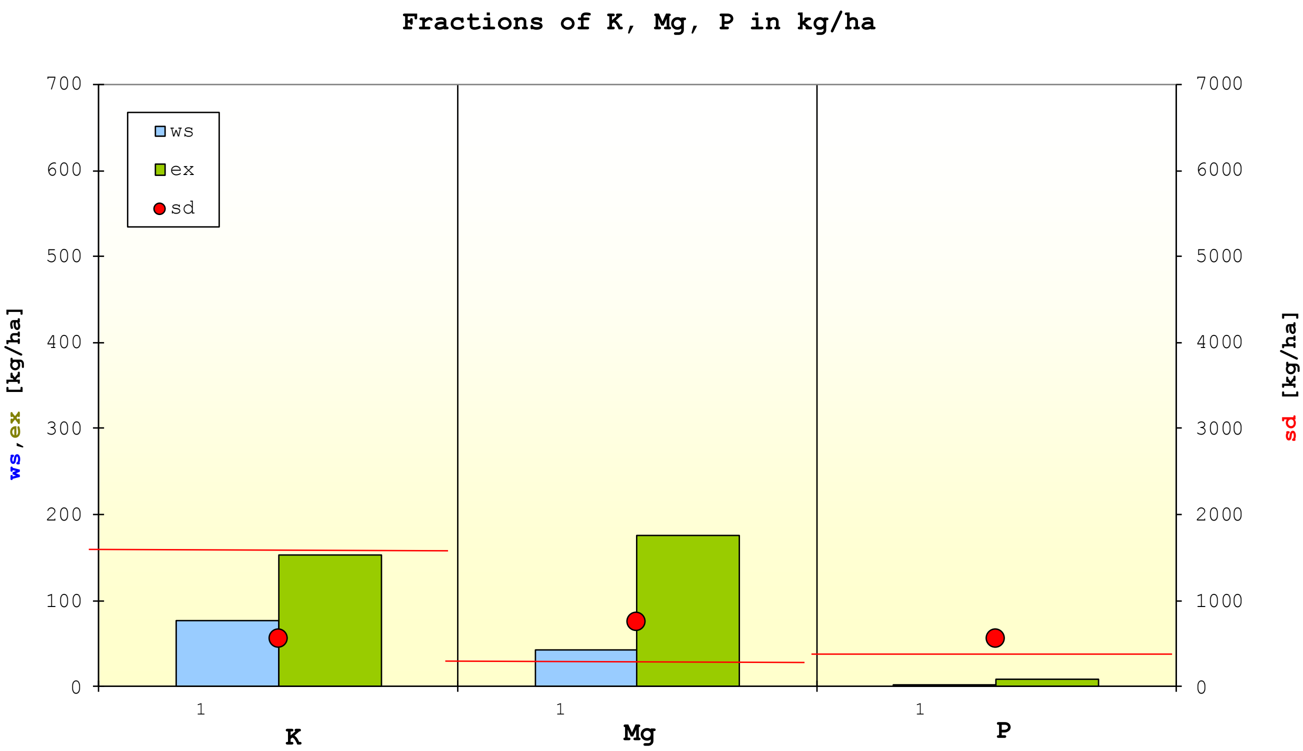


Figure 4: Fractions of the nutrients K, Mg, P (ws=water-soluble, ex=exchangeable, sd=subsequent deliverable). All contents are net values (ex without ws, sd without ex and without ws)

The figure and the following tables depict the **plant available** parts **at the time of the sampling**. Looking at this **snapshot** it is not ecologically useful if the full amount of nutrients, required for the stated crop and yield level for one growing season, is present in an easily available form.

Potassium

Table 4: Different K-pools of the soil, 1

element	availability	quantity kg/ha	remarks
K	water-soluble	77,1	sufficient
K	exchangeable	153	surplus
K	subsequent deliverable	550	well filled

Magnesium

Table 5: Different Mg-pools of the soil, 1

element	availability	quantity kg/ha	remarks
Mg	water-soluble	42,9	sufficient
Mg	exchangeable	176	application for melioration
Mg	subsequent deliverable	750	well filled

Phosphorus

Table 6: Different P-pools of the soil, 1

element	availability	concentration mg/l	quantity kg/ha	quantity in % P total	remarks
P	water-soluble	0,30	0,6	0,03	sufficient
P	exchangeable		8	0	serious shortage
P	subsequent deliverable		550	31	mineral reserves high
P	organic		832	47	organic reserves high
P	total		1784		total contents middle

The P-concentration in the ***soil solution*** is **0,30 mg/l** and lies in the beneficial range for a good plant development. In total around **8 kg/ha** of P are present in ***plant available*** form. This amount is not sufficient for the whole growing season. But through microbiological and chemical processes an ongoing mobilization of P out of the reserve fraction can be assumed, depending on temperature and moisture conditions.

The ***acid-soluble reserve pool*** is well filled with approx. **550 kg/ha** of P, in the ***organic reserve pool*** (humus) approx. **830 kg/ha** of P are stored. I order to sustainably secure the P-supply measures should be undertaken to sustainably **mobilize P** from the **reserve pools.**
To do so a number of strategies are suitable, like:

- Improvement and stabilization of the acid systems (e.g. application of dolomite, lime)
- Supporting the microbial activity (e.g. improvement of ventilation, supply with trace elements, green manure, catch crops, leaving the straw on the field)
- Ion competition (e.g. silicate)
- Cultivation of P-unbarring plants (e.g. buckwheat, white lupine)
- Application of P-unbarring bacteria (megaterium phosphoricum)

Trace Elements

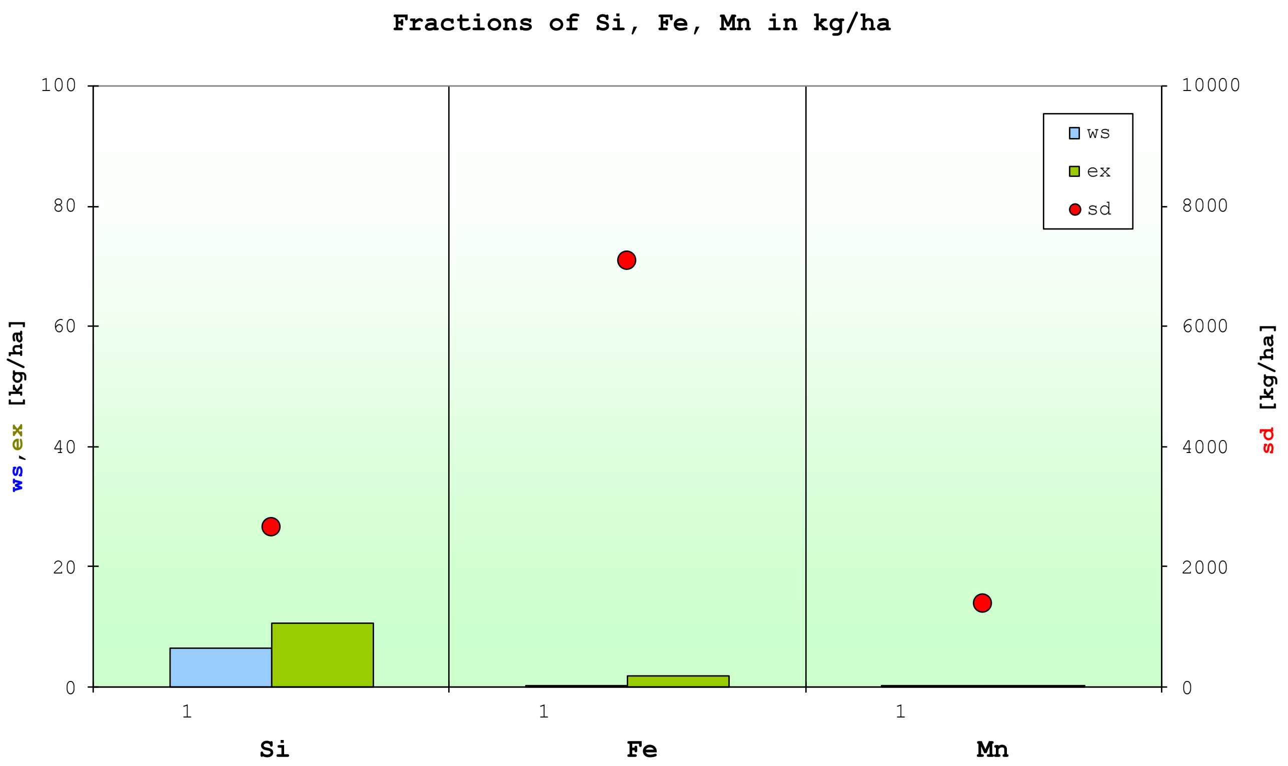


Figure 5: Fractions of the nutrients Si, Fe, Mn (ws=water-soluble, ex=exchangeable, sd=subsequent deliverable). All contents are net values (ex without ws, sd without ex and without ws)

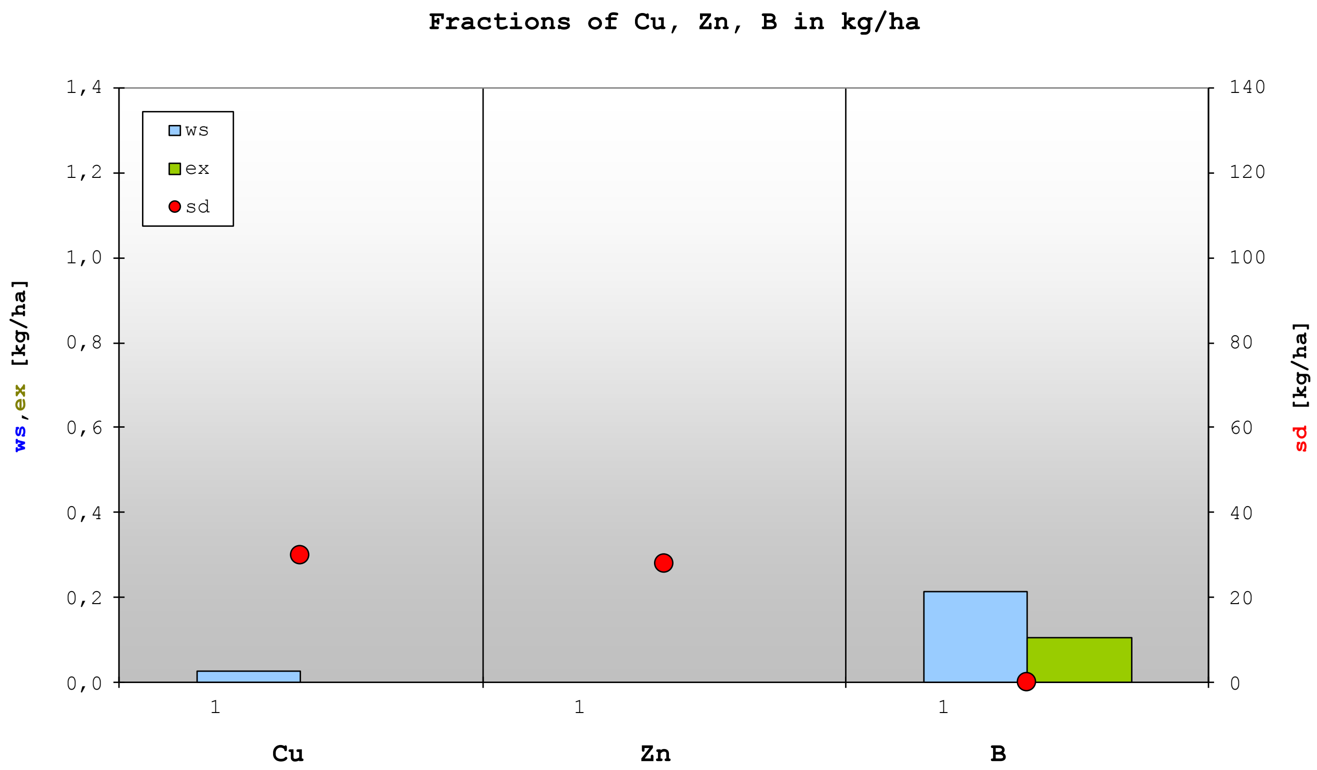


Figure 6: Fractions of the nutrients Cu, Zn, B (ws=water-soluble, ex=exchangeable, sd=subsequent deliverable). All contents are net values (ex without ws, sd without ex and without ws)

Table 7: Trace elements in different pools, 1

element	plant available kg/ha	reserve pool kg/ha	recommended application via soil kg/ha
Si	17	2650	Si is able to mobilize P
Fe	2	7090	none
Mn*	0,04	1390	1,60
Cu	0,03	30,0	none
Zn	0,00	27,8	1,60
Co	0,11	12,0	none
Mo	0,00	0,00	0,18
B	0,32	0,00	none

Attention: Surplus of Fe!

* The reserve contents of manganese (**Mn**) are high. Mn is mobilized in the soil especially by reductive conditions (=air shortage) and acid. After rainfall events and under wet conditions many pores in the soil are filled with water, Mn is mobilized sufficiently. During dry periods Mn is fixed strongly. Despite the high Mn contents in the soil an addition of Mn could be useful in these situations (the application should take place via the leaves).

Toxic Elements

Because of the water-soluble contents of chrome (**Cr**), lead (**Pb**), nickel (**Ni**) there is a risk of contamination for adjacent systems (e.g. water bodies, ground water).

With kind regards

Univ.Lek. DI. Hans Unterfrauner

***Remark**: The interpretation and the recommended measures refer to the soil sample that was sent in. We assume no liability for the quality of the sampling process and the sample itself.*

A-2544 Leobersdorf
Aredstraße 13 Top 3-4

Tel: +43 2256 64 186
Fax: +43 2256 64 186 -21
Email: agrar@waterandwaste.at

water & waste
Wasser- und Abfallwirtschaft
Abt. Agrar- und Bodenkunde

SOIL SURVEY

Customer:	TB Unterfrauner GmbH	Laboratory Nr.:	agr15-0590.1
Address:	Erdbergstraße 10/33	Label:	4826 Boden
	1030 Wien	Crop:	W-Rapeseed
Site designation:	OT4833	Depth:	0-30cm yield: 4.00t
Sampling date:			

PARAMETER	SYMBOL	UNIT	VALUE	PARAMETER	I H_2O	II exch.	III subs. del.	IV total
Class of soil texture	KH	-	42,4	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Electric conductivity	eL	mS/cm	1,115	Ca	74,08	357,27	1082	
Lime content	$CaCO_3$	%		Mg	12,07	49,41	167,32	
Water content	WGF	%	11,31	K	21,69	43,02	124,70	
Reaction (w)	pH-H_2O	-	7,43	Na	3,07	2,02	90,60	
Reaction (n)	pH-$CaCl_2$	-		NH_4-N	0,01	0,19		
Reaction (a)	pH-KCl	-	6,46	H	<0,01	0,14		
Exchange capac. (T)	CEC_p	mmolc/100g	5,49	Al	<0,0042	0,29	870,71	
Base saturation	BS	% CECp	42,07	Ba	0,08	0,38	36,81	
Active T-part	Ta/Tp		0,42	PO_4	0,39	5,28	482,23	
Ca- part on T	Ca%	% CECp	32,47	P	0,13	1,72	157,27	
Mg- part on T	Mg%	% CECp	7,40	NO_3-N	35,84			
K- part on T	K%	% CECp	2,00	SO_4	36,09			
Na- part on T	Na%	% CECp	0,16	Cl	10,51			
NH_4-N- part on T	NH_4-N%	% CECp	0,02	HCO_3	99,58			
H^+- part on T	H^+	% CECp	0,26	SiO_3	4,91	8,42	1582	
Al- part on T	Al%	% CECp	0,06	BO_3	0,32	0,15	<5,44	
Ba- part on T	Ba%	% CECp	<0,01					
Potential acid part	Sp%	% CECp	57,60	Ag	<0,0030	<0,0373	<2,00	
Abb.org.substance	AOS	%	1,52	Fe	0,02	0,44	1560	
Org. carbon	C_{org}	%	0,88	Mn	0,0005	0,01	305,69	
Total. nitrogen	N_t	mg/kg	660,0	Cu	0,0071	<0,0382	6,61	
Org. nitrogen	N_{org}	mg/kg	624,0	Zn	<0,0085	<0,0466	6,13	
Min. nitrogen	N_{min}	mg/kg	36,0	Co	0,0023	0,03	2,64	
H_2O-solu.nitrogen	N_l	mg/kg	35,9	Mo	<0,0017	<0,0373	<0,0700	
Tot. sulphur	S_t	mg/kg	100,0	B	0,06	0,03	<1,00	
Tot. Phosphorus	P_t	mg/kg	392,6	Sn	0,01	0,09	0,89	
Org. Phosphorus	P_{org}	mg/kg	183,1	Se	<0,0254	<1,1184	<3,60	
Min. Phosphorus	P_{min}	mg/kg	209,5	As	<0,0152	<0,7456	2,01	
C/P-ratio	C/P	m/m	48,3	Ni	0,0053	<0,0336	1,53	
C/S-ratio	C/S	m/m	88,4	Cr	0,0028	<0,0345	1,31	
C/N-ratio	C/N	m/m	13,4	Pb	0,01	0,34	18,79	
Rel.H_2O-capac.	RWK	%Gew.		Cd	<0,0003	<0,0103	0,13	
Wet density	FDICHTE	g/l		Hg				
Dry density	TDICHTE	g/l		Tl	<0,0254	<0,9320	<4,00	
Extrverh. I	EXI	l/kg	0,42	V	0,0008	<0,0084	5,14	
Extrverh. II	EXII	l/kg	9,32					
Colouring/turbidity	FT		12					

Engrossment: 25.06.15

Receipt of the sample: 26.05.15
Remark: