



SOIL BALANCING

Soil analysis and fertiliser recommendation

SOIL BALANCING means analysing the nutrients present in the soil in their ratios to one another and, where necessary, modifying these ratios through fertilisation in order to achieve a balance of nutrients – because that is when their availability increases. The efficiency of fertilisation and nutrient uptake is thus at its highest for the crops and the soil life, and soil tilth improves. So the soil life is fertilised too – not just the plants!

The German researcher Oscar Loew gained the first insights into the effectiveness of certain nutrient ratios as early as the beginning of the 20th century. The American William A. Albrecht built on this work. He recognised that antagonistic effects of nutrients in the soil can influence the health of animals and humans through the food chain. Through research on humans, animals and plants he discovered a specific nutrient ratio or balance in the soil at which not only did the plants grow healthier and better, but the health of humans and animals was also positively influenced. In addition, positive effects on soil condition and reduced weed pressure were observed.

This method has been researched, modified and further developed by many researchers and practitioners – such as Graeme Sait, Werner Bergmann, Jerry Brunetti, André Voisin, Matt Kleinhenz and many others. It is gaining more and more acceptance in practice. The soil analyses and interpretations of your soil samples are therefore prepared on the basis of the current state of research and the further developed findings of Loew and Albrecht.

Your samples were analysed by the accredited German laboratory of the AGROLAB GROUP in Sarstedt. By merging the laboratory expertise of the Albrecht laboratory (Brookside Laboratories, USA) with the accredited German standard, a scientifically sound and meaningful procedure is used here to measure the nutrients analytically.

The resulting fertiliser recommendations have one sole aim: to bring the nutrients in your soil into balance over the years – so-called SOIL BALANCING.

The fertiliser recommendations may in some cases be very high – please therefore observe closely the recommended application priorities, application timings and the maximum quantity per year. All recommended fertilisers are listed in the FiBL input list and are therefore also permitted in organic farming.

If, as a first-time user, you feel unsure, you can initially carry out the fertilisation on part of the area only and let the positive effects convince you. Always bear in mind, however, that depending on the imbalance present it can take up to three years before the first desired effects appear.

Enjoy analysing and implementing the results!

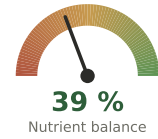
Lucas Kohl · BodenBalance – Kohls GbR

PS: Should you have any questions, I am happy to help.

Soil Balancing · soil analysis & interpretation

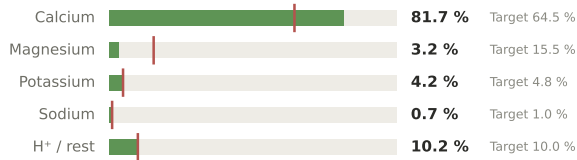
BASIC SOIL DATA

pH value (CaCl ₂)	4.9	pH value (H ₂ O)	5.8 · target 6.0–6.5
Humus (org. matter)	0.9 %	C/N ratio	8.7 · target ~10–12
Soil type	sand	CEC act	2.8 cmol ⁺ /kg
CEC pot	6.9 cmol ⁺ /kg	Bulk density	1.67 g/cm ³ · calculated
ENR (N release)	≈ 51 kg N/ha · estimated		

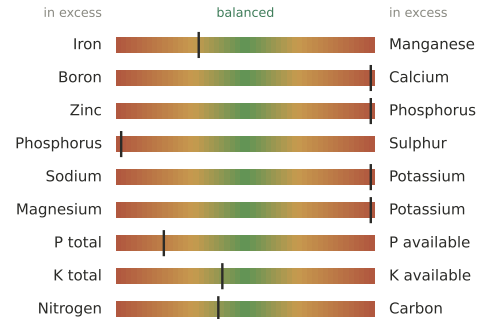


CEC act < CEC pot = unused sorption potential. ENR (Estimated Nitrogen Release) = estimated N release from organic matter during the growing season (humus content, C/N, pH).

BASE SATURATION OF THE POTENTIAL EXCHANGER (CEC POT)



NUTRIENT RATIOS



NUTRIENT CONTENTS (MEHLICH-3)

	ACTUAL	TARGET
Macronutrients · kg/ha		
Sulphur (S)	29.2	104
Phosphorus (P)	739	155
Calcium (Ca)	1,386	3,732
Magnesium (Mg)	117	538
Potassium (K)	434	547
Sodium (Na)	54.3	69.6
Micronutrients · kg/ha		
Boron (B)	0.459	2.51
Iron (Fe)	1,528	731
Manganese (Mn)	488	283
Copper (Cu)	8.35	12.5
Zinc (Zn)	18.0	41.8
Molybdenum (Mo)	n. a.	1.54 not analysed
Cobalt (Co)	n. a.	10.4 not analysed
Selenium (Se)	n. a.	2.92 not analysed

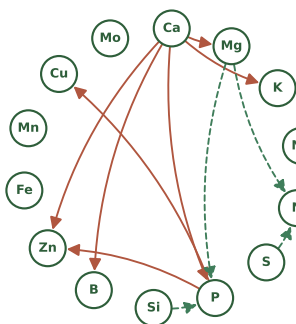
Marker = position of ACTUAL relative to target (centre = target reached); red = unfavourable, green = optimal.

LUFA STANDARD ANALYSIS · CONTENT CLASSES

(Brandenburg · DL method)

Phosphorus (P, DL)	6.5 mg/100 g	Cl. C
Potassium (K, DL)	8.5 mg/100 g	Cl. C
Magnesium (DL)	2.5 mg/100 g	Cl. B

NUTRIENT INTERACTIONS (MULDER)



Negative interaction (antagonism) – solid red arrows: a nutrient in excess suppresses another (direction = effect).

Positive interaction (synergism) – green dashed, can be used deliberately to restore the balance.

Only the negative interactions present in this sample and the synergisms that can be used for balancing are shown.

INTERPRETATION & NOTES

Calcium in excess

Ca saturation 81.7 % (target 64.5 %) – calcium dominates the exchanger and displaces magnesium and potassium.

Phosphorus fixation by calcium

Phosphorus not available – fixed as calcium phosphate (Ca saturation 81.7 %, pH (CaCl₂) 4.9).

Magnesium deficiency

Mg saturation 3.2 % (target 15.5 %). Magnesium deficiency weakens chlorophyll formation and energy transport in the plant.

High acid potential on the exchanger

H share on the exchanger 10.2 % at pH (CaCl₂) 4.9 – risk of the pH dropping into the acidic buffer range.

Sulphur and boron deficient

Imbalance with nitrogen and calcium – plant availability restricted, hence protein synthesis restricted.

Extreme manganese excess

Mn 117.0 mg/kg (target 67.7), Mn/Fe = 0.3, May be an indicator of reducing (oxygen-poor) conditions.

Unused sorption potential

Large difference between CEC act (2.8) and CEC pot (6.9 cmol⁺/kg) – can be utilised through liming and humus build-up.

Fertiliser recommendation

Fertiliser	Quantity	Covers	Period	Application / note
Dolomite 60 % CaCO ₃ · 25 % MgCO ₃	2,990 kg/ha	Calcium + magnesium (building up base saturation)	spread over 3–4 years	Basic fertilisation (Ca + Mg); continue maintenance liming according to carbonate test. Do not mix with trace elements – apply at separate times.
Kieserite 25 % MgO · 50 % SO ₃	170 kg/ha	Magnesium (+ sulphate sulphur)	2–3 years	Readily water-soluble; spread in spring into the growing crop or the cover crop, split into several applications over the years. Also covers the sulphate share of the sulphur.
Magnesia kainite 9 % K ₂ O · 4 % MgO · 36 % Na ₂ O · 8 % SO ₃	50 kg/ha	Potassium + magnesium + sodium (+ sulphate S)	1–2 years	Covers K, Mg and Na together; spread. Note the chloride – not shortly before chloride-sensitive crops.
Potassium sulphate 50 % K ₂ O · 45 % SO ₃	80 kg/ha	Potassium	1–2 years	Low K requirement – can be covered in one application. Spread in spring into the growing crop.
Boric acid 17.4 % B	7 kg/ha	Boron	2–3 years	Cannot be applied in advance; foliar application, repeat annually as required.
Zinc sulphate 36 % Zn	18 kg/ha	Zinc	2–3 years	Do not mix with lime/calcium or with water-soluble phosphorus; more effective with humic acids.
Copper sulphate 23 % Cu	14 kg/ha	Copper	2–3 years	Not together with lime/calcium – apply at separate times; more effective with humic acids.

NOTES ON IMPLEMENTATION

Application – cover crop, clover/lucerne grass or high-uptake main crop: The recommended fertiliser quantities may in some cases be very high. Application causes a temporary imbalance to which the soil biology first has to adjust. Preferably apply in cover crops or clover/lucerne grass stands – there the nutrients are dynamised and are available to the following crop in the right ratio. Alternatively, the fertilisers can also be applied directly to main crops with a good uptake capacity for the respective nutrient – there up to a maximum of twice the crop requirement per application. High-uptake crops:

Sulphates (S): Oilseed rape, brassica and allium vegetables, grain legumes, grassland

Calcium: Oilseed rape, potatoes, brassicas, clover/lucerne grass, grassland

Magnesium: Potatoes, beet, maize, clover/lucerne grass

Potassium: Beet, potatoes, maize, brassicas, clover/lucerne grass

Sodium: Sugar/fodder beet (sodium-loving), fodder kale

Phosphorus: Potatoes, maize, clover/lucerne grass, grassland

Boron: Oilseed rape, sugar/fodder beet, sunflowers, brassicas, lucerne

Molybdenum: Grain legumes, clover/lucerne grass, brassicas, oilseed rape

Cobalt: Grain legumes (field bean, soya, lupin, pea), clover/lucerne grass

Copper: Oats, wheat, barley, sunflowers, grassland

Zinc: Maize, flax, hops, fruit growing

Manganese: Oats, wheat, sugar/fodder beet, peas/field beans

Selenium: Grassland (forage quality)

Maintenance liming: continue independently of these recommendations. Check the requirement annually with the hydrochloric acid test: if the test is negative (no free lime reserve left), an annual top-dressing with a seaweed or chalk lime enriched with calcium sulphate is recommended in the period autumn to spring (depending on the lime 90 to 240 kg/ha).

Organic fertilisation: Carrier materials (rock dust / biochar) should be mixed into organic fertilisers to prevent leaching and to avoid overloading the exchanger with nutrients.

Phosphorus availability / silicon: Where phosphorus availability is restricted due to an unfavourable pH value, an unfavourable base saturation or an unbalanced ratio to zinc, an additional application of silicic acid (silicon) can be useful. Applying silicon-containing rock dusts can contribute to the mobilisation of fixed phosphorus via anion competition and support the plant-available phosphorus fraction.

Trace elements: Do not apply zinc (or copper, manganese, iron, cobalt) together with lime/calcium – apply at separate times. For application they can also be mixed together into slurry/compost (instead of foliar application). Additionally, do not mix zinc with water-soluble phosphorus.

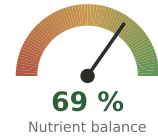
Systemic approach: The method only achieves the desired success in combination with consistent cover cropping, undersowing and mixed cropping.

The calculated fertiliser quantities are guide values for closing the identified nutrient gap; compliance with the applicable fertiliser legislation (e.g. fertiliser ordinance, closed periods, farm-level limits) is the responsibility of the farm. The values and recommendations shown do not replace individual professional advice and are not legally binding.

Soil Balancing · soil analysis & interpretation

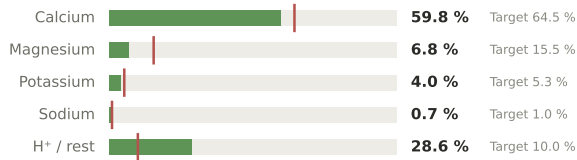
BASIC SOIL DATA

pH value (CaCl ₂)	6.5	pH value (H ₂ O)	7.1 · target 6.0–6.5
Humus (org. matter)	1.3 %	C/N ratio	12.6 · target ~10–12
Soil type	sand	CEC act	4.7 cmol⁺/kg
CEC pot	6.7 cmol⁺/kg	Bulk density	1.64 g/cm³ · calculated
ENR (N release)	≈ 61 kg N/ha · estimated		

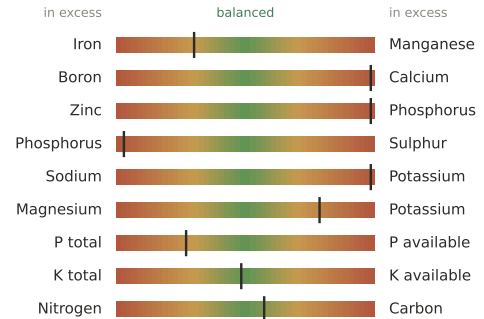


CEC act < CEC pot = unused sorption potential. ENR (Estimated Nitrogen Release) = estimated N release from organic matter during the growing season (humus content, C/N, pH).

BASE SATURATION OF THE POTENTIAL EXCHANGER (CEC POT)



NUTRIENT RATIOS



NUTRIENT CONTENTS (MEHLICH-3)

	ACTUAL	TARGET	
Macronutrients · kg/ha			
Sulphur (S)	32.8	113	
Phosphorus (P)	541	152	
Calcium (Ca)	3,219	3,554	
Magnesium (Mg)	250	512	
Potassium (K)	394	567	
Sodium (Na)	12.3	63.7	
Micronutrients · kg/ha			
Boron (B)	1.31	2.46	
Iron (Fe)	1,169	718	
Manganese (Mn)	353	277	
Copper (Cu)	19.3	12.3	
Zinc (Zn)	19.3	41.0	
Molybdenum (Mo)	n. a.	1.56	not analysed
Cobalt (Co)	n. a.	11.3	not analysed
Selenium (Se)	n. a.	2.87	not analysed

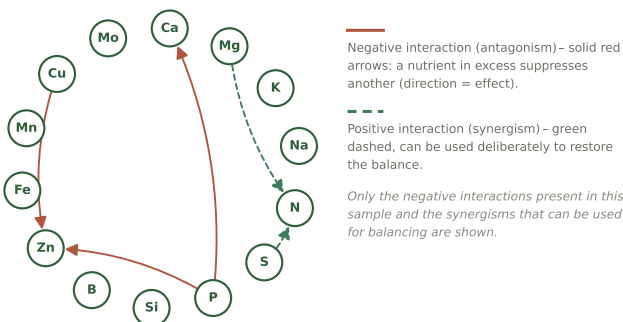
Marker = position of ACTUAL relative to target (centre = target reached); red = unfavourable, green = optimal.

LUFA STANDARD ANALYSIS · CONTENT CLASSES

(Brandenburg · DL method)

Phosphorus (P, DL)	7.2 mg/100 g	Cl. C
Potassium (K, DL)	9.3 mg/100 g	Cl. C
Magnesium (DL)	6.7 mg/100 g	Cl. E

NUTRIENT INTERACTIONS (MULDER)



INTERPRETATION & NOTES

Calcium deficiency

Ca saturation 59.8 % (target 64.5 %) – building up base saturation through liming takes priority.

Magnesium deficiency

Mg saturation 6.8 % (target 15.5 %). Magnesium deficiency weakens chlorophyll formation and energy transport in the plant.

High acid potential on the exchanger

H share on the exchanger 28.6 % at pH (CaCl₂) 6.5 – risk of the pH dropping into the acidic buffer range.

Sulphur and boron deficient

Imbalance with nitrogen and calcium – plant availability restricted, hence protein synthesis restricted.

Unused sorption potential

Large difference between CEC act (4.7) and CEC pot (6.7 cmol⁺/kg) – can be utilised through liming and humus build-up.

K/Mg ratio unfavourable

K/Mg = 1.6 – not because of too much potassium but because of missing magnesium. The ratio improves as Mg is built up.

C/N ratio too wide

C/N = 12.6 – humus-building processes restricted.

Fertiliser recommendation

Fertiliser	Quantity	Covers	Period	Application / note
Elemental sulphur 90 % S	20 kg/ha	Sulphur (30 % of requirement)	over 1–2 years	Slow-acting → apply first and ideally half a year before the other nutrients; the remaining sulphur is covered by the sulphate fertilisers.
Kieserite 25 % MgO · 50 % SO ₃	170 kg/ha	Magnesium (+ sulphate sulphur)	2–3 years	Readily water-soluble; spread in spring into the growing crop or the cover crop, split into several applications over the years. Also covers the sulphate share of the sulphur.
Magnesia kainite 9 % K ₂ O · 4 % MgO · 36 % Na ₂ O · 8 % SO ₃	50 kg/ha	Potassium + magnesium + sodium (+ sulphate S)	1–2 years	Covers K, Mg and Na together; spread. Note the chloride– not shortly before chloride-sensitive crops.
Calcium sulphate (gypsum) 33 % CaO · 46 % SO ₃	180 kg/ha	Sulphate sulphur + calcium	2–3 years	Supplies Ca and sulphate sulphur without raising pH; spread in spring. Do not combine with water-soluble P (fixation).
Potassium sulphate 50 % K ₂ O · 45 % SO ₃	90 kg/ha	Potassium	1–2 years	Low K requirement – can be covered in one application. Spread in spring into the growing crop.
Boric acid 17.4 % B	9 kg/ha	Boron	2–3 years	Cannot be applied in advance; foliar application, repeat annually as required.
Zinc sulphate 36 % Zn	18 kg/ha	Zinc	2–3 years	Do not mix with lime/calcium or with water-soluble phosphorus; more effective with humic acids.

Magnesium build-up without additional calcium:

Magnesium is strongly deficient. The deficit is balanced with kieserite (MgSO₄) – magnesium without additional Ca supply via dolomite. Maintenance liming according to the carbonate test is unaffected by this (see notes).

NOTES ON IMPLEMENTATION

Application – cover crop, clover/lucerne grass or high-uptake main crop: The recommended fertiliser quantities may in some cases be very high. Application causes a temporary imbalance to which the soil biology first has to adjust. Preferably apply in cover crops or clover/lucerne grass stands – there the nutrients are dynamised and are available to the following crop in the right ratio. Alternatively, the fertilisers can also be applied directly to main crops with a good uptake capacity for the respective nutrient – there up to a maximum of twice the crop requirement per application. High-uptake crops:

Sulphates (S): Oilseed rape, brassica and allium vegetables, grain legumes, grassland

Calcium: Oilseed rape, potatoes, brassicas, clover/lucerne grass, grassland

Magnesium: Potatoes, beet, maize, clover/lucerne grass

Potassium: Beet, potatoes, maize, brassicas, clover/lucerne grass

Sodium: Sugar/fodder beet (sodium-loving), fodder kale

Phosphorus: Potatoes, maize, clover/lucerne grass, grassland

Boron: Oilseed rape, sugar/fodder beet, sunflowers, brassicas, lucerne

Molybdenum: Grain legumes, clover/lucerne grass, brassicas, oilseed rape

Cobalt: Grain legumes (field bean, soya, lupin, pea), clover/lucerne grass

Copper: Oats, wheat, barley, sunflowers, grassland

Zinc: Maize, flax, hops, fruit growing

Manganese: Oats, wheat, sugar/fodder beet, peas/field beans

Selenium: Grassland (forage quality)

Elemental sulphur with boron: Additional application of elemental sulphur with boron (e.g. 30 kg/ha Wigor S&B) at sowing of the main crops is advisable.

Maintenance liming: continue independently of these recommendations. Check the requirement annually with the hydrochloric acid test: if the test is negative (no free lime reserve left), an annual top-dressing with a seaweed or chalk lime enriched with calcium sulphate is recommended in the period autumn to spring (depending on the lime 90 to 240 kg/ha).

Organic fertilisation: Carrier materials (rock dust / biochar) should be mixed into organic fertilisers to prevent leaching and to avoid overloading the exchanger with nutrients.

Trace elements: Do not apply zinc (or copper, manganese, iron, cobalt) together with lime/calcium – apply at separate times. For application they can also be mixed together into slurry/compost (instead of foliar application). Additionally, do not mix zinc with water-soluble phosphorus.

Systemic approach: The method only achieves the desired success in combination with consistent cover cropping, undersowing and mixed cropping.

The calculated fertiliser quantities are guide values for closing the identified nutrient gap; compliance with the applicable fertiliser legislation (e.g. fertiliser ordinance, closed periods, farm-level limits) is the responsibility of the farm. The values and recommendations shown do not replace individual professional advice and are not legally binding.

Soil Balancing · comparison of fields

Example field A (clover) **Example field B (spring oats)**

Bar up to the red centre line = TARGET reached;
shorter = deficit, longer = excess (scale up to 2 × TARGET)

BASIC SOIL DATA — DEVIATION FROM TARGET

pH (CaCl ₂) · target	Example field A	–1.3	
6.0–6.5	Example field B	+0.2	
pH (H ₂ O) · target	Example field A	–0.5	
6.0–6.5	Example field B	+0.8	
C/N · target ~11	Example field A	–2.3	
	Example field B	+1.6	
Nutrient balance % · target 100	Example field A	–61	
	Example field B	–31	

BASE SATURATION (CEC POT) · % — DEV. FROM TARGET

Calcium	Example field A	+17.2	
	Example field B	–4.7	
Magnesium	Example field A	–12.3	
	Example field B	–8.7	
Potassium	Example field A	–0.7	
	Example field B	–1.3	
Sodium	Example field A	–0.3	
	Example field B	–0.3	

FURTHER INDICATORS (WITHOUT TARGET)

Humus %	Example field A	0.9	
	Example field B	1.3	
H ⁺ / rest %	Example field A	10.2	
	Example field B	28.6	
CEC pot cmol ⁺ /kg	Example field A	6.9	
	Example field B	6.7	
CEC act cmol ⁺ /kg	Example field A	2.8	
	Example field B	4.7	
Bulk density g/cm ³	Example field A	1.67	
	Example field B	1.64	
ENR kg N/ha	Example field A	51	
	Example field B	61	
P ₂ O ₅ (DL) mg/100 g	Example field A	15.0	
	Example field B	16.4	
K ₂ O (DL) mg/100 g	Example field A	10.3	
	Example field B	11.2	
Mg (DL) mg/100 g	Example field A	2.5	
	Example field B	6.7	

Bar length relative to the larger of the two values.

NUTRIENT CONTENTS · kg/ha — DEV. FROM TARGET

Sulphur	Example field A	–75.2	
	Example field B	–80.0	
Phosphorus	Example field A	+584	
	Example field B	+389	
Calcium	Example field A	–2,346	
	Example field B	–336	
Magnesium	Example field A	–421	
	Example field B	–262	
Potassium	Example field A	–113	
	Example field B	–173	
Sodium	Example field A	–15.3	
	Example field B	–51.4	
Boron	Example field A	–2.0	
	Example field B	–1.1	
Iron	Example field A	+797	
	Example field B	+451	
Manganese	Example field A	+206	
	Example field B	+75	
Copper	Example field A	–4.2	
	Example field B	+7.0	
Zinc	Example field A	–23.8	
	Example field B	–21.7	

FERTILISER RECOMMENDATION · kg/ha

Dolomite	Example field A	2,990	
	Example field B	0	
Kieserite	Example field A	170	
	Example field B	170	
Magnesia kainite	Example field A	50	
	Example field B	50	
Potassium sulphate	Example field A	80	
	Example field B	90	
Boric acid	Example field A	7	
	Example field B	9	
Zinc sulphate	Example field A	18	
	Example field B	18	
Copper sulphate	Example field A	14	
	Example field B	0	
Elemental sulphur	Example field A	0	
	Example field B	20	
Calcium sulphate (gypsum)	Example field A	0	
	Example field B	180	

Bar length relative to the larger of the two quantities (no target reference).