

Influence of mid-term application of composts on chemical, physical and biological soil properties of agricultural soils in field trials of practical importance

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Project base

- > Mid-term compost trials on five farm sites
- > Application of quality-controlled composts (mostly from bio-waste)
- > Predominantly loamy and clayey soils (Forchheim: sandy)
- > Uniform experimental design
- > Uniform mineral N fertilization steps
- > Uniform crop rotation: maize/winter wheat/winter barley
- > Integral concept encompassing benefits and risks to derive recommendations of application



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Site characteristics

location	region	soil texture	clay content %	type of compost	runtime til 2006 (y)
Forchheim	Rhine valley	IS	10	biowaste	12
Weierbach	Kraichgau	uL	27	green waste	12
Stockach	Hegau	utL	26	biowaste	12
Ellwangen	Ostalb	utL	29	biowaste	9
Heidenheim	Ostalb	uL	27	biowaste	9

Soil texture: IS - loamy sand; uL – silty loam; utL – silty clayey loam

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Experimental design

Var.-No.	factors	
	Compost application <i>t/ha DM per year</i>	min. N-fertilization <i>% of optimum per year</i>
1	without	without
2	without	50
3	without	100
4	5	without
5	5	50
6	5	100
7	10	without
8	10	50
9	10	100
10	20	without
11	20	50
12	20	100

corresponds to 25 t/ha
rsp. 50 t/ha/fresh matter
every 3 years

extreme variant

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Compost characterization

General properties		mean	range
Dry matter	% FM	64,1	
pH value		7,5	
Org. substance		38,4	35 - 45
C/N-ratio		17,0	15 -17
Basic active sub-stance	CaO	4,54	3 - 6
Nutrient parameter		% DM	% DM
Nitrogen	N	1,41	1,2 - 1,6
Phosphorus	P ₂ O ₅	0,68	0,5 - 0,7
Potassium	K ₂ O	1,09	0,8 - 1,3
Magnesium	MgO	0,78	0,5 - 0,9

→ Classification as NPK fertilizer resp. NP-fertilizer according to the German fertilizer ordinance

The contents for green waste composts on average are 20 to 30 % lower

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Soil organic substance – humus balance

annual supply with compost		compost supply in t/ha DM every 3 years	
		20	30
Organic Substance	t/ha DM	2,4 - 2,8	3,6 - 4,0
Carbon total	t/ha	1,3 - 1,7	2,0 - 2,4
Thereof C reproducible	t/ha	0,6 - 0,9	1,0 - 1,3
Annual average humus demand of soil in t/ha Carbon		Humus demand of soil	
		medium	high
Humus content	optimal	0,2 - 0,4	0,6 - 0,9

→ Compost application on average meets the humus demand due to its high content of reproducible C

Increase of humus content after 9 resp. 12 years of compost application (topsoil):

Compost application rate (DM)	Increase of humus content (%)
5 t/ha	0,2 - 0,4
10 t/ha	0,4 - 0,8
20 t/ha	1,4 - 1,8

→ The positive humus balance is essential to the enhancement of soil biology. The humus increase is less at the sandy site.

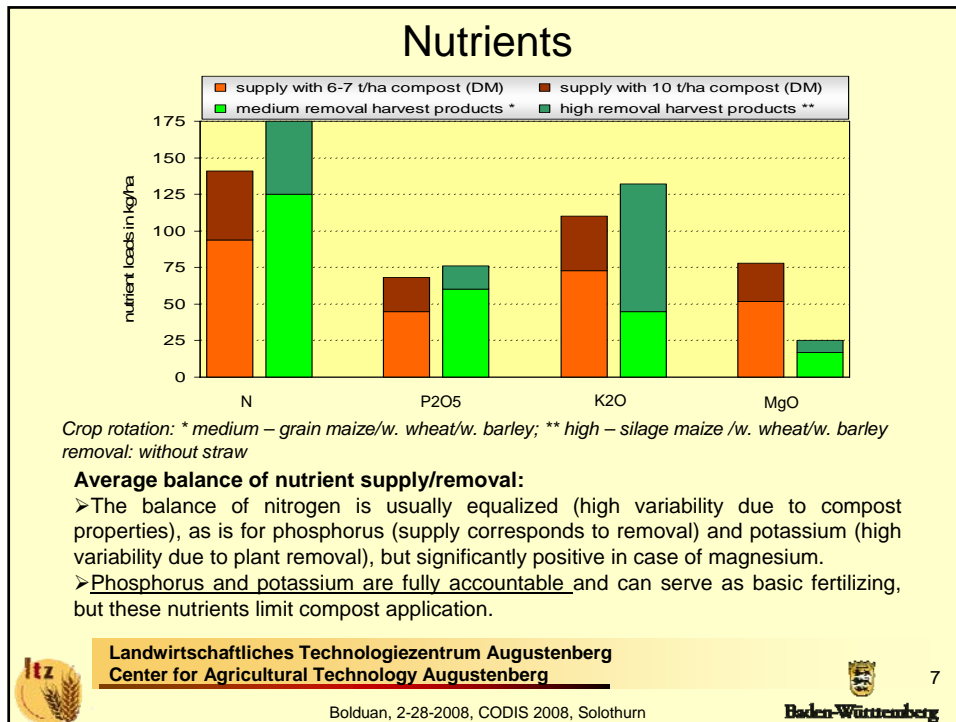
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Nutrients II

N Mineral nitrogen utilization from compost and resulting accountable nitrogen availability: annually only up to 5 % at the beginning, in medium term **5 to 10%**, i.e. supplementary fertilization with nitrogen and control of soil Nmin-content is essential; Increase of soil Nmin for medium compost supply on average by about 5 kg/ha to 10 kg/ha

P The content of soluble phosphate in the composts averages to **15 to 25 %** of the total content, indicating **high fertilization efficiency**. An increase of soluble soil phosphate was found. Its extent is determined by the actual pH value and redox potential of the soil. **Stabilization of the nutrient supply** with compost application

K The content of soluble potassium in composts averages to **65 to 70%** of the total content also indicating **high fertilization efficiency**. An increase of the soluble fraction in soils was found. **Stabilization of the nutrient supply** with compost application to counteract leaching losses

Mg The plant available fraction averages to **7 to 10 %** of the total content and the **fertilization efficiency is of minor extent**; the positive nutrient balance counteracts permanent leaching. An increase of soluble Mg in soils could not be observed

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Lime status and pH-value

Due to high average supply with basic substances

- a compensation of **lime removal on sandy soils** is possible with the medium application rate (about 2 – 4 t/ha lime by 20 t/ha compost every three years)
- **lime removal of loamy and clayey soils** could be compensated with the high application rate (supply of 4 – 5,5 t/ha lime by 30 t/ha compost every three years)
- With the medium application rate, the **pH-value could be conserved or even raised** by about 0,2 to 0,4 pH-units



Lime supply approximately equals the liming application rate for preservation of soil pH



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Soil improvement

Base: Results of all sites enhanced by data of the latest investigations on the sites Forchheim (sandy, highest temperature) and Stockach (loamy clayey; higher precipitation) over 12 years and Heidenheim (loamy, lowest temperature) over 9 years.

Soil physics and water household

Parameter	Test sites				
	Forchheim	Weierbach	Stockach	Ellwangen	Heidenh.
Soil structure					
Aggregate stability	—	↑↑	↗	↑↑	↗
porosity	↑↑	↑	↑↑	—	—
Air capacity	↗	n.a.	↑↑	n.a.	—
Bulk density	↑↑	↗	↑↑	↑	—
Water household					
Usable field capacity	↑↑	↑↑	↑	—	↗
Water content	↑↑	↑	↑	↑↑	↗
Water capacity	↑↑	↑	↑↑	↑	↑↑
Water conductivity	—	↗	—	—	—

- ↑↑ definite improvement, direct correlation with compost supply
- ↑ measurable tendency towards improvement
- ↗ Uncertain tendency towards improvement
- no influence
- n.a. not analysed

- Enhanced heat storage due to compost mulch → growth promotion at start of vegetation
- Enhanced porosity and bulk stability → enhanced aeration and drainage
- Increased aggregate stability → increase of trafficability and erosion resistance, fuel savings
- Upgraded water capacity/water infiltration → high moisture reserves, water logging prevention



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Soil improvement II

Soil biology

Parameter	Test sites				
	Forchheim	Weierbach	Stockach	Ellwangen	Heidenh.
Soil microbiology					
Microbial biomass	↑↑	↑	↑↑	↑↑	↑↑
Phosphatase activity	↑↑	n.a.	↑↑	n.a.	↑↑
N-mineralisation	↑↑	n.a.	↑↑	↑	↑↑

↑↑ definite improvement, direct correlation with compost supply
 ↑ measurable tendency towards improvement
 ↗ Uncertain tendency towards improvement
 n.a. not analysed

- Enhanced microbial biomass → overall activation of soil biota, high phytosanitary resilience
- Increased enzyme activity → improved mineralization (esp. of bound nitrogen)

Consequences:

- Conservation or gradual promotion of soil fertility
- Improved land use



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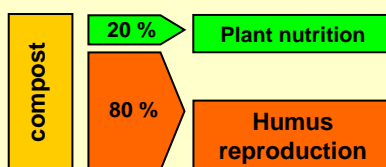


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Conclusion



Recommendation for good agricultural practice and quality assurance:

Medium-sized application of quality controlled (biowaste) compost of 20 t/ha dry matter corresponding to **35 to 40 t/ha fresh matter (mulch) on a three years time scale** proved as optimum for plant production. Supplementary nitrogen fertilization of the recommended optimum can be reduced by **annually 5% in the first three years** and by **further 5 to 10 % annually as from the forth year**. This promises a minimum of risks.



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Summary

- Compost serves as organic NPK-fertilizer; replacing preservation liming
- Main effect: soil improvement; humus formation and reproduction
- Better land use
- Conservation of soil fertility
- Protection of resources
- *Benefit of compost is the sum of all single effects*

The complete report will presumably be published on April 2008:

Nachhaltige Kompostanwendung in der Landwirtschaft. Abschlussbericht 2007. (Sustainable compost application in agriculture. Final report 2007) LTZ Augustenberg, Karlsruhe



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Thank you for your attention!



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