



*Beneficial use of compost on agricultural soils –
benefits and risks*

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Earlier

- ◆ Compost was produced from agricultural waste by farmers, who also used to be the end-users for compost.
- ◆ The benefits were straight forward, and there were no risks.

Now

- ◆ Compost is produced from a variety of municipal organic wastes by urban waste management companies.
- ◆ Link between the producers and the users is broken, and there is mistrust against using compost on farmland.



Utilisation of compost

- ◆ Is the compost of good quality?
 - ... and what is ‘quality’?
- ◆ Are there any obvious benefits?
- ◆ Are there any risks?

- ◆ Does compost meet my needs?
- ◆ Does compost replace mineral fertilisers?

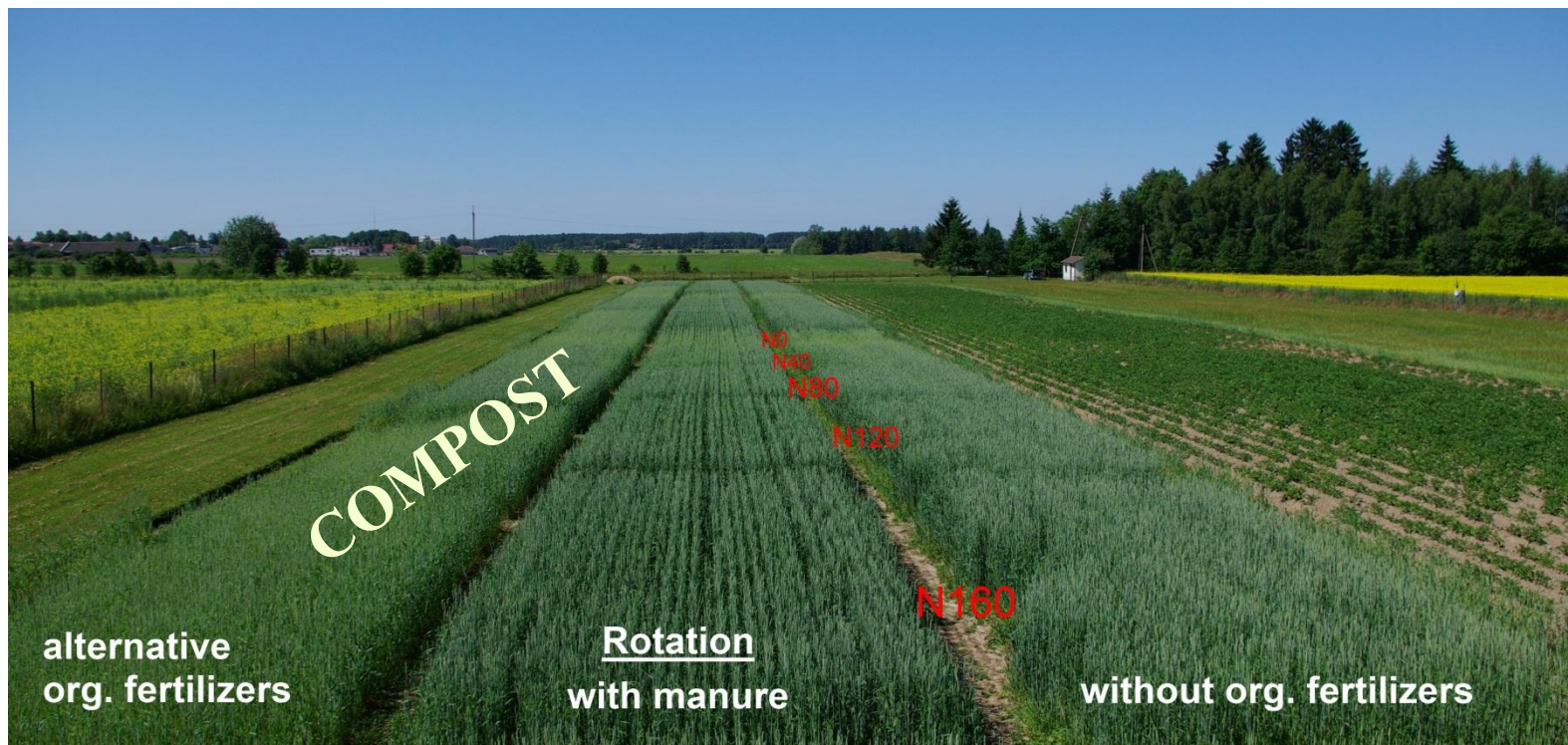
Field trials



Field trials



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Long-term field test

Test location	Region of Baden-Württemberg, Germany
Soils	Intermediate-type and heavy soils, (one location sandy)
Composts	Quality assured biowaste compost (4) + green waste compost (1)
Test period	12 years (3 locations) 9 years (2 locations)
Test parameter	Compost application: 0 (control), 5, 10, 20 t/ha DM/y N-supplementing fertilisation: 0, 50, 100 % of fertilizer optimum
Test design	Randomised block design: 12 alternatives with 4 repetitions, in total 48 test lots
Crop rotation	corn/winter wheat, winter barley

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Humus

Annual supply with compost		Compost supplies in t/ha DM 3 year rotation			
		20		30	
Organic matter	t/ha DM	2.4	- 2.8	3.6	- 4.0
Carbon (C)	t/ha	1.3	- 1.7	2.0	- 2.4
Thereof C reproducible	t/ha	0.6	- 0.9	1.0	- 1.3
Annual humus demand of soil in t/ha carbon		Humus demand of soil			
		average		high	
Humus content	optimal	0.2	- 0.4	0.6	- 0.9
	suboptimal	0.4	- 0.6	1.2	- 1.6

- ◆ As a rule the humus content of the soil can be covered to a large extent.
- ◆ The **humus balance** is positive, or at least stable.

Humus

- ◆ The increasing compost supply caused an extensive linear increase of **humus contents**.
- ◆ Even relatively low annual compost supply (5 t/ha) provided measurable increases of humus contents of approximately 0.2 – 0.4 %.
- ◆ The increase in humus content in soils can be calculated as 0.1 % per 8 – 9 t/ha DM of organic compost substance.
- ◆ The increase of humus contents on sandy soils was slightly lower than on medium to heavy soils.

Humus

- ◆ A medium compost dose of 15 – 20 t/ha DM in a 3 year rotation is sufficient to influence the humus balance positively.
 - High compost supply (>20 t/ha) is recommended in soils with extremely low humus content.
- ◆ The increase of humus content was registered for <30 cm top soils only – change your tilling habits?!
- ◆ No increased degradation of organic carbon in soils was registered – thus a sustainable humus enrichment of soils at a regular compost application was proved.



Soil structure

- ◆ The bulk density of the soil was reduced.
- ◆ The total pore portion increased (not on heavy soils).
- ◆ Drainage and aeration improved.
- ◆ Aggregate stability of the soils increased.
(less obvious – expected on medium and heavy soils, but not on sandy soils)
- ◆ Increased workability – reduced fuel consumption.
- ◆ Less erosion on slope areas.

Water content

- ◆ *Water holding capacity* improved.
(obvious on medium to heavy soils, smaller on sandy soils)
- ◆ *Water content* increased 1 – 2 %.
- ◆ *Usable field capacity* increased.
(more medium-sized and coarse pores)
 - Crops are able to resist longer lasting droughts, mainly on light soils.
 - Farmers observed more rapid drying of soils after heavy rainfall.



Soil biology

- ◆ The portions of *microbial biomass* significantly improved.
- ◆ The *phytosanitary potential of the soil*, its ability to resist harmful organisms, was improved.

Supply of nutrients

- ◆ The medium **nutrient supply** of compost application for crop cultivation is 20 to max 30 t /ha DM every 3 y.

<u>Annual supplies</u>	Compost doses (t/ha DM) in a 3-years rotation		Assessment
	20 - average	30 - high	
Nutrients in kg/ha	Medium ranges		Average nutrient balance
Nitrogen - N	80 - 110	120 - 160	Slightly negative (medium doses) resp. balanced to slightly positive (high doses), at high removals balanced
Phosphorous - P ₂ O ₅	35 - 55	60 - 80	Predominantly balanced
Potassium - K ₂ O	60 - 85	100 - 120	Removals medium: positive Removals high: slightly negative to balanced
Magnesium - MgO	35 - 60	60 - 85	Always highly positive

Fertilising efficiency

- ◆ *Soluble i.e. plant available* contents in soil – fertilising efficiency.
- ◆ The N-mineralisation equilibrium in the soil is moved towards the soluble and thus fertilising effective N-portions.
(mechanism – the activity of the soil organisms)



Plant availability and fertilising efficiency

- ◆ The soluble ‘plant available’ (N & K) fraction of nutrients:
 - Without fertilising (0 compost added) it decreased.
 - With compost application dose of 5 t/ha DM annually reduction was compensated to some extent.
 - With compost application dose of 10 t/ha DM annually reduction was fully balanced.
- ◆ Mg evolution due to fertilising with compost did not achieve phytotoxic limits.

Plant availability and leaching

- ◆ Soluble phosphorus content were mostly found in the tilled topsoil.
 - Diminishing P content in soil layers of 30–60 cm.
 - P was rarely found in layers of 60–90 cm.
- ◆ No measurable potassium and magnesium in deep layers.
- ◆ No leaching to groundwaters!

pH

- ◆ Lime supply with compost applications in regular intervals serves as *maintenance liming*.
 - Also in deeper soil layers.
- ◆ As a magnitude an up-rating of about 0.1 pH-units per 10 t/ha CaO from compost application was determined.
- ◆ Compost doses (crop cultivation) of 20 to 30 t/ha DM in a 3-year rotation were positively influencing the lime balance of the soil.
 - Large doses serve as remediation measures.



Possible risks

impacts on soils and harvest products

- ◆ Heavy metals.
- ◆ Hazardous organic compounds.
- ◆ Epidemic and phytohygiene effects.
- ◆ Weed seeds.
- ◆ Impurities and stones.
- ◆ N-mineralisation.

Heavy metals in soil

- ◆ A *positive balance* always remains in the soils.
 - Minimum heavy metal removal by harvested products.
- ◆ Metal accumulation in soil can not be excluded, but it was *extremely small* in the study.
 - Accumulation is very slow, analytically determined not before 10–20 y.
- ◆ The contents of (Pb, Cd, Cr, Ni, Hg) *did not rise* in soil during the field trials after 9–12 years of compost application (20 t/ha DM annually).
- ◆ The contents of Cu and Zn showed a *slightly increasing* tendency (> 10 t/ha DM annually).
 - This took place in topsoil, not in deeper layers.
- ◆ Heavy metal *mobility* was generally missing or decreased (Cd, Ni and Zn).



Heavy metals in plants

- ◆ The heavy metal contents in harvest products remained unchanged during the trials compared with control (no compost application).
- ◆ The quality of food plants, which are fertilised with compost in regular intervals is not endangered by heavy metals, according to the particular long-term trial.
- ◆ Precautionary soil protection is recommended – heavy metal supply with compost must be lowered as much as possible.



Organic pollutants

- ◆ Persistent PCB contents were very low, ranging close to the background/analytical detection levels.
- ◆ Other organic pollutants (organochlorine pesticides, polycyclic aromatic hydrocarbons, phtalates etc) had no influence not even with an excessive application doses.
- ◆ In total there was no indication for an enrichment of organic pollutants in the soils resulting from a compost application.



Impurities and stones

- ◆ **Impurities and stones** are no longer a problem when quality assured composts are used.
- ◆ The contents of impurities > 2 mm are below a mean value of 0.1 % DM.
- ◆ Impurities from plastic foils can massively damage the visual appearance of the compost (reputation of compost!).
- ◆ Stones can be classified as a lower-ranking risk.



Hygiene aspects

- ◆ 65° C over a period of 7 days eliminates risks from epidemic and phytohygienic pathogen contents.
 - salmonella disappears.
 - coliform bacteria ranged below the harmless guide values.
- ◆ High total contents of bacteria and fungi indicates high biological activity of composts, which is desirable.

Weeds

- ◆ The number of **germinable weed** in composts show harmless ranges if hot decomposition stage is achieved during composting.
- ◆ **Quality assured composts** are virtually free from germinable weed seeds.
- ◆ The result of 54 annual ratings of the total weed ground cover degree showed in no case a measurable weed stock which could have been attributed to compost application.
 - Confirmed by farmers.

Conclusions

Compost is a ‘multifunctional product’

- ◆ Compost shows many application possibilities.
 - It is mainly used to improve the **soil** (soil fertilizer),
 - And as **plant nutrition** (plant fertilizer).
 - ◆ Compost delivers 3 to 4 times higher reproduction rates of humus carbon for soils compared to straw, liquid manures and anaerobic digestion products.
 - ◆ The humus level of the soil has direct effect for the soil structure and the soil's ability to store water and nutrients.
 - improved workability e.g. less fuel consumption of tractors
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Conclusions

Fertilizer effect is slow

- ◆ The fertiliser effect from application of mineral fertilisers is fast, but the effect is short.
- ◆ The fertiliser effect from application of compost is slow.
 - The fertiliser effect arrives in several years, but lasts longer
 - Apply compost regularly over 3 to 10 years
- ◆ Soil-improving effect of regular compost application **dominates** (compared to fertiliser effect).

Conclusions

Successful use of compost

- ◆ Particularly important are the results of long-term use of compost, which is the key for long-term markets, and trust of customers.
- ◆ The success of sustainable use of composts on agricultural soils is depending on:
 - well controlled input material,
 - well maintained composting process,
 - good chemical composition of the compost,
 - application rates.





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To believe, or not to believe – this is the question.

Thank you!

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