

Plastic contamination of soil: is compost the source?

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Motivation and Research Questions

Plastic contamination is a major environmental topic, however, only little knowledge exists about plastic contamination of agroecosystems. Especially the prevalence of plastic in soil and potential entry paths remain largely unknown. Consequently, this study aims at evaluating to what degree compost application is a source of plastic for soil.

Hypotheses

1. Compost contains macro- and microplastic; the content of plastic is mainly depends on conditions of compost production.
2. Compost application will lead to enhanced plastic contents in soil.

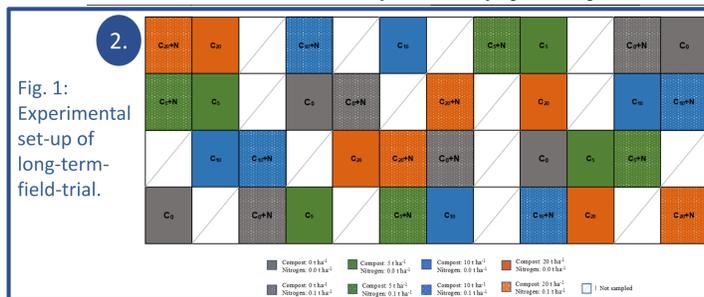
Materials

1. Compost
Eight different compost types obtained from different compost plants and hardware stores, including compost produced from green cutting and biowaste were analyzed.

2. Soil
Topsoil (0-30 cm) of a 12-year compost fertilizer trial with 0, 5, 10 and 20 t compost per hectare with and without N-fertilization was analyzed.

Table 1: Origin, raw material and code of analyzed compost types.

Origin	Description	Raw material	Code
Plant A	Municipal bio-waste derived compost, sieved (0-20 mm)	Biowaste from households	PlantA-Bio-20
	Municipal green waste compost, sieved (0-25 mm)	Municipal green cutting	PlantA-GC-25
Plant B	Municipal green waste fine compost, sieved (0-10 mm)	Municipal green cutting	PlantB-GC-10
	Municipal green waste compost, sieved (0-25 mm)	Municipal green cutting	PlantB-GC-25
	Municipal green waste structure compost, sieved (0-45 mm)	Municipal green cutting	PlantB-GC-45
Hardware store	Commercial garden compost	Municipal green cutting	HS1-GC
	Commercial garden compost	Municipal green cutting	HS2-GC
	Commercial raised bed compost	Municipal green cutting	HS3-GC



Methods

1.&2.

Method testing and adjustment

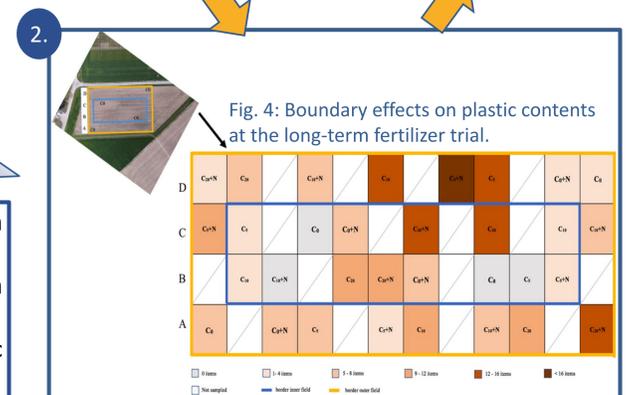
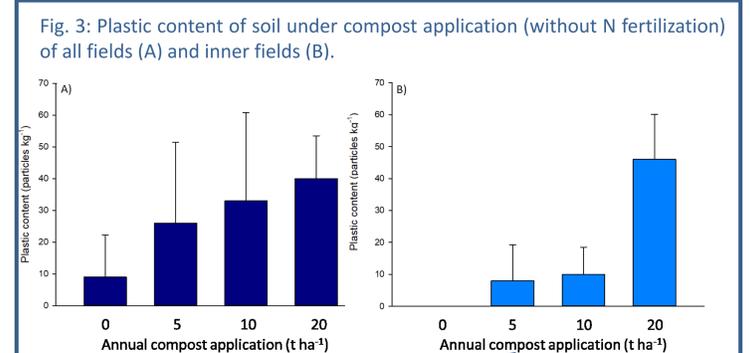
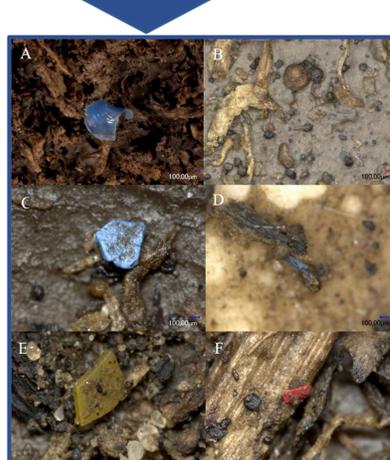
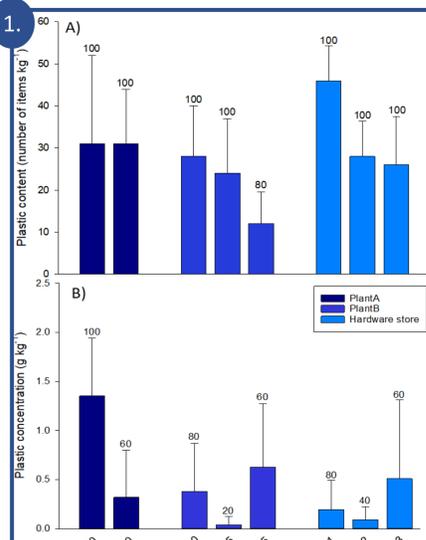
Soil and compost were spiked with plastic of different type and size. Density separation (ZnCl₂) with/without ultrasonic and H₂O₂ treatment was tested.

Density separation (ZnCl₂) without ultrasonic and H₂O₂ treatment was most successful treatment (80±29% recovery).

Analysis of plastic in compost and soil

Plastic was identified using a digital video microscope (DVM, Keyence VHX 1000 model, VH-ZR lens). Determination of plastic contents (number of particles kg⁻¹) and concentrations g kg⁻¹, for mesoplastic)

Results



All analyzed composts contained plastic, fragments were dominant plastic shape. Highly variable plastic contents (12±8 to 46±8 particles kg⁻¹) and concentrations (0.04±0.08 to 1.35±0.59 g kg⁻¹).

Micro- and mesoplastic contents were highly variable but increased with increasing compost application. Soils with compost application had 2 to 2.5 higher plastic concentrations than control variants. Additional plastic sources at the field border lead to 3 to 9 times higher plastic contents, leading to a plastic contamination of up to 23 items kg⁻¹.

Discussion

1. No significant differences between compost types were detected.

Calculated **yearly plastic contamination of agricultural fields** via compost application:

Compost application 7 t per ha:
84,000 – 217,000 items per ha
0.28 – 9.45 kg per ha

Compost application 35 t per ha:
420,000 – 1,085,000 items per ha
1.4 – 47.25 kg per ha

Calculated **yearly plastic contamination of horticultural soil** via compost application:

Compost application 6.48 t per ha:
77,770 – 200,880 items per ha
0.26 – 8.75 kg per ha

Compost application 19.44 t per ha:
233,280 – 602,640 items per ha
0.78 – 26.24 kg per ha

2.

Estimated plastic contents of soil (based on plastic contents of compost) are substantial higher than found plastic contents in soil of the fertilizer trial:

High variability of plastic contents in compost and soil?

Discharge of plastic from soil (vertical movement, aeolian transport)?

Conclusion

Compost application is a entry path for plastic in soil.

Plastic contents in compost and soil are highly variable.

Additional sources contribute to plastic pollution of agricultural fields.

Further research is needed to quantify smaller plastic particles!