Table of frass agronomic value

Deliverable 1.4

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Content

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1. Agronomic potential of frass

Frass is the excrement of insects and other arthropods, which can be used as a soil amendment or fertilizer in agriculture. Frass has the potential to be an excellent source of plant nutrients, as it contains high levels of nitrogen, phosphorus, potassium, and other micronutrients. Research has shown that frass can improve plant growth and yield, increase soil fertility, and enhance plant resistance to pests and diseases. Frass also contains beneficial microorganisms that can help promote soil health and nutrient uptake by plants.

There are certain legal limitations that must be considered when utilizing insect frass in agricultural fields in the EU. On November 29th, 2021, Regulation (EU) 2021/1925 established EU baseline standards for the production and sale of insect frass as organic fertilizer. The new law modified Annex I and Annex XI of Regulation (EU) No 142/2011 by harmonizing the heat treatment process standards for frass with those for processed animal manure, requiring frass to be treated at **a minimum of 70 degrees Celsius for one hour** to be sold in EU Member States, in accordance with national authorization procedures. With the establishment of EU baseline standards for insect frass, the use of insect frass in organic production will be permissible starting from January 1st, 2022 (as outlined in Commission Regulation EU 889/2008, which covers the use of worm dejecta, vermicompost, and insect frass-substrate mixtures).

The chemical composition of BSF frass (fresh without heat treatment) is shown in

Table 1. The dry matter content of the frass (and the corresponding “dilution” rate of N, P and K), is strongly dependent on the rearing conditions (type of feed, layer thickness of the feed, ambient temperature and relative humidity, ventilation conditions, microbial activity, ...). This will codetermine how much fresh frass can be applied on the field to fullfill the nitrogen demand of the crop.

Table 1: Composition of frass after black soldier fly production on different substrates. The final average (± standard deviation) is a global average that encompasses additional substrates.

BSF diet	Number of measurements	Dry matter (% FM)	Organic matter (% DM)	Nitrogen (% DM)	Phosphorous (P_2O_5) (% DM)	Potassium (K_2O) (% DM)
Gainesville	6	42.0%	86.1%	3.31%	3.49%	3.98%
Farm 1 Crumble	11	51.1%	83.4%	3.79%	3.96%	2.84%
Retail mix (bread and vegetables)	4	65.9%	92.7%	3.22%	0.72%	1.43%
Retail mix (bread, vegetables and dairy)	4	64.2%	93.4%	3.26%	0.85%	1.13%
Extended average	30	57.6% ± 11.2	88.1% ± 3.9	3.64% ± 0.48	2.76% ± 1.57	2.36% ± 0.91

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As a reference, Figure 1 and Figure 2 show how fresh frass compares to other sources of livestock manure. Due to its higher dry mattter content, both nitrogen and phosphorous are in the higher range compared to other livestock.

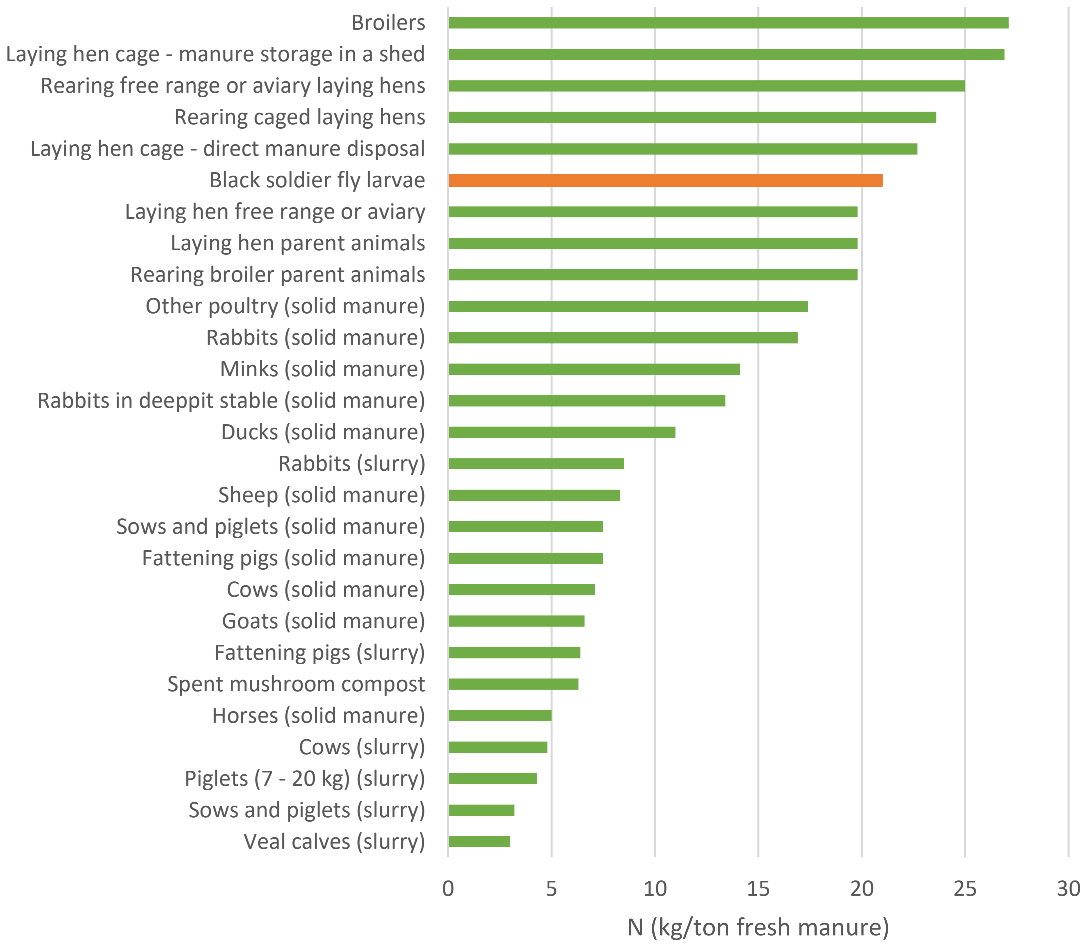

Figure 1: The nitrogen content of fresh BSF frass and how it compares to the manure of other livestock.

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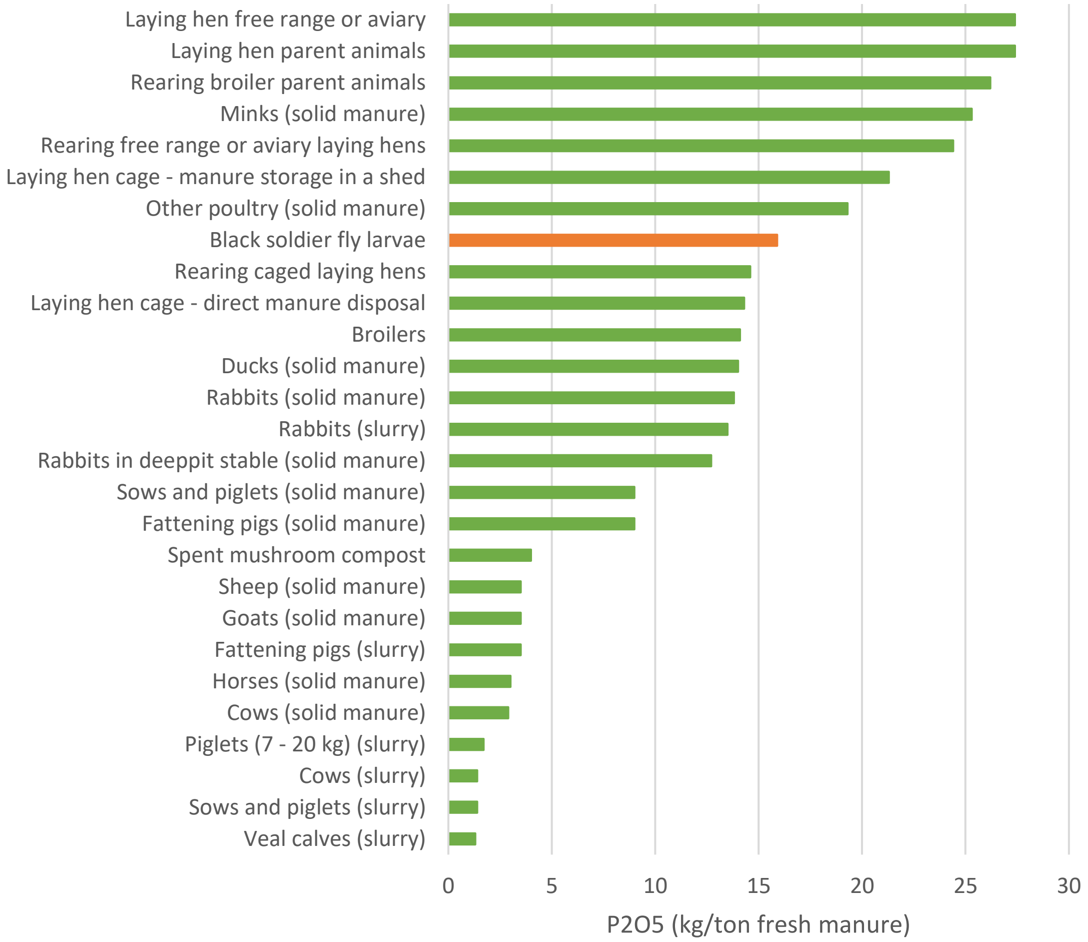

Figure 2: The phosphorous content (in P_2O_5 equivalents) of fresh BSF frass and how it compares to the manure of other livestock.

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2. Field trial with cauliflower

To asses the agronomic potential of BSF frass a field trial was performed where the frass was used in organic cauliflower production. In addition to its role as a fertiliser, its potential as a biostimulant was assessed. More specificallly its potential to control the cabbage root fly (*Delia radicum*) (CRF). The cabbage root fly is a pest that primarily affects plants in the Brassicaceae family, including cabbage, broccoli, cauliflower, radish, and turnip. The larvae of the cabbage root fly feed on the roots of these plants, which can cause significant damage and even kill the plant. BSF frass has previously shown promise in reducing CRF damage to plant roots.

To be in line with EU legislation, heat treated, dried frass was used for this trial. Two application methods were compared, the frass as is and the same frass that has been pelletised.

The BSF frass or pellets was applied just after planting the plants in the field at a dose of ca. 80 g/plant. This dose is distributed manually on the soil around the base of the plants within a diameter of 15 cm. The dose of 80 g/plant corresponds to a field dose of 3850 kg/ha. The nitrogen content of the BSF frass and pellets was analysed and indicated 117 and 107 tonnes/ha of total N, respectively. Calculating with a working coefficient of 30% (because of the limited ammonium nitrogen in relation to total N and high C/N ratio), this means that a supply of 35 and 32 kg N/ha, respectively. To correct for the N-supply by these two treatments, all other plots were supplemented with 300 kg/ha OPF organic granular fertiliser (11-0-5). This amount completes the crop demand deficit (about 36 kg/ha) which was not fulfilled with the base fertilisation from solid cattle manure and with soil mineralisation.

The number of CRF larvae were scored per plant, the results are shown in Table 1. No significant reduction of CRF infestation was found compared to the control treatment.

Table 2: Effect of the treatments on the number of CRF larvae per plant, found in and around the stem and roots of the cauliflower plants.

Treatment	Damage accululation
Control	1.2 a
Insecticide	0.0 b
Nematodes 1	0.4 ab
Nematodes 2	0.5 ab
Nematodes 3	0.5 ab
Nematodes 4	0.5 ab
BSF frass	0.3 ab
Nematodes 5	0.5 ab
BSF pellets	0.7 ab
Applied statistical test	*Tukey*
C.V. (%)	*51.4*
p-value	*0.04*

Not only the number of larvae was scored, also the amount of damage that was done to the plants (Table 3). No significant reduction of damage was observed in the BSF treatments.

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Table 3: Effect of the treatments on the damage accumulation caused by CRF larvae to the roots of cauliflower plants (planting date 28 April 2022). The damage is scored on a scale from 1 (= no damage) to 5 (= roots completely degraded and stem almost completely hollowed out).

Treatment	Damage accululation
Control	3.0 a
Insecticide	1.8 b
Nematodes 1	2.8 a
Nematodes 2	2.7 a
Nematodes 3	3.0 a
Nematodes 4	3.0 a
BSF frass	3.0 a
Nematodes 5	3.0 a
BSF pellets	2.8 a
Applied statistical test	*Tukey*
C.V. (%)	*10.1*
p-value	*< 0.001*

Lastly, general crop performance was scored (Table 4). Here BSF frass did result in a leafier healthier crop compared to the control treatment.

Table 4: Effect of the treatments on the crop condition in the field scored on a scale from 1 to 9 (1= very poor; 9= very good), the foliar mass (1= very few; 9= much) and the uniformity of the crop stand (1= very heterogeneous; 9= homogenous).

Treatment	Crop stand	Leaf mass	Uniformity
Control	4.8 b	4.3 c	5.3 c
Insecticide	6.1 a	6.4 a	7.4 a
Nematodes 1	5.5 ab	5 abc	6.4 abc
Nematodes 2	5.3 ab	5 abc	6.8 ab
Nematodes 3	5.3 ab	5.3 abc	6.4 abc
Nematodes 4	5.6 ab	4.9 bc	6.4 abc
BSF frass	5.5 ab	5.4 ab	6.5 ab
Nematodes 5	5.4 ab	5.4 ab	6.3 abc
BSF pellets	5 b	5 abc	6.1 bc
Applied statistical test	*Kruskal-Wallis*	*Kruskal-Wallis*	*Tukey*
C.V. (%)	*8.64*	*7.76*	*7.81*
p-value	*0.048*	*0.007*	*0.001*

During the trial, the growth of the crop was impacted by various factors that limited its growth. Although the cabbage root fly pressure did not reach a high peak density of larvae on the plants, the risk of damage was consistently high due to continuous egg-laying throughout the cropping period. Unfortunately, none of the treatments tested were able to adequately control the damage caused by the cabbage root fly under these conditions.

While the two fertilizer treatments did not have a direct effect on CRF or its damage to the plants, they did reduce the total plant loss in the trial. However, previous and parallel trials have

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shown that applying 80 g of BSF frass per plant at planting tends to decrease the damage caused by CRF to the plant roots. Although we did not observe a direct suppressive effect on larvae in any of the trials, we did confirm the positive effect of BSF frass on plant growth in this trial. This effect is due to biostimulation since we corrected the other treatments for nitrogen fertilization.

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