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Insect Frass as a Soil Amendment in Arkansas

Ana Morales-Ona Smith
Assistant Professor and Extension Soil Fertility Specialist - Department of Crop, Soil, and Environmental Sciences

Helen Carla Amorim
Research Scientist - Department of Crop, Soil, and Environmental Sciences

Amanda Ashworth
Research Leader Soil Scientist, United States Department of Agriculture - Agricultural Research Service

Gerson Drescher
Assistant Professor of Soil Fertility - Department of Crop, Soil, and Environmental Sciences

Keith Driver
Sustainability Specialist - Tyson Foods

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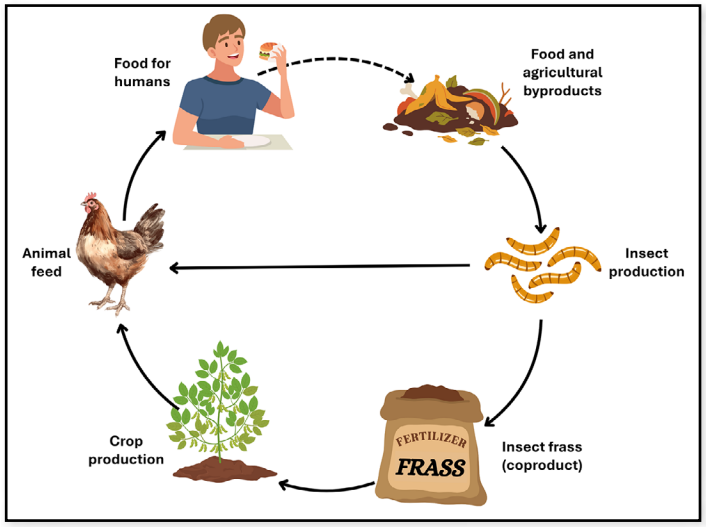
Insect frass is a coproduct of insect farming that consists primarily of insect excreta, exoskeletons, and may contain residual feed. It has been evaluated for agricultural use in Arkansas by researchers at the University of Arkansas Division of Agriculture and the United States Department of Agriculture-Agricultural Research Service (USDA ARS) in Fayetteville. Results indicate that insect frass is a high-value, multi-nutrient soil amendment that has the potential to complement traditional fertilizers and improve soil health.

This factsheet highlights research findings and aims to help growers and agricultural professionals better understand insect frass, its potential benefits as a soil amendment, and considerations for its use.

Frass as a coproduct of insect farming

Insect farming involves raising insects, sometimes referred to as “mini livestock,” that can be used as a source of protein and energy in animal feeds, pet foods, and in some cases, human food. Commercially important species include black soldier flies, yellow mealworms, and crickets because of their production efficiency and feed conversion. Black soldier fly larvae can be processed into ingredients

Figure 1. Insect frass production cycle showing the transformation of organic waste inputs into a high-value soil amendment. *Illustration by Helen Amorim via Canva.*



for aquaculture, livestock, and poultry feed and pet food. Yellow mealworms and crickets are commonly used in pet food or processed into food products for human consumption, such as protein powder. Some insect species are raised on food and agricultural byproducts, including materials such as pre-consumer food waste that would otherwise be discarded (Figure 1). The materials used as feed vary among insect species and production systems.

"Frass" is the primary coproduct of insect production and consists mainly of insect excreta, shed exoskeletons (exuviae), and may contain remaining feed, with an average nitrogen (N) – phosphorus (P) – potassium (K) composition (%) of 4-2-2. For comparison, poultry litter is a byproduct of poultry production, widely used as an organic fertilizer in Arkansas production systems. It consists of poultry manure mixed with bedding, spilled feed, and other materials generated during production and has an average N-P-K composition (%) of 3-2-2.

Composition of different frass types

Frass contains carbon (C) and essential plant nutrients, including nitrogen, phosphorus, potassium, calcium (Ca), magnesium (Mg), and sulfur (S). However, its composition and appearance (Figure 2) vary among insect species, feedstocks, and production systems. Table 1 summarizes the average chemical characteristics of frass from three major insect groups used commercially — black soldier flies, yellow mealworms, and crickets — and compares them with poultry litter. Before determining frass application rates, obtaining a nutrient analysis of the specific product is recommended. In Arkansas, frass samples can be submitted for nutrient analysis for a fee to the Fayetteville Agricultural Diagnostic Laboratory using Form AGRI-429.

Figure 2. Examples of variation in appearance among insect frass samples. *Photo credit: Paden Johnson.*



Property	Units	Poultry litter[1]	Insect Frass Type[2]		
			Black soldier fly	Yellow mealworm	Cricket
Total carbon (C)	%	36.8	30.7	39.7	34.5
Total nitrogen (N)	%	4.8	2.9	3.6	3.9
Carbon-to-nitrogen ratio (C:N)	—	7.5	10.6	11.3	8.9
pH	—	7.8	7.1	6.1	6.4
Electrical conductivity	dS m^{-1}	11.9	6.4	5.4	7.2
Phosphorus (P)	%	1.5	1.7	3.2	1.9
Potassium (K)	%	3.3	2.7	4.2	2.8
Calcium (Ca)	%	1.9	1.2	0.3	2.4
Magnesium (Mg)	%	0.7	0.6	1.2	0.6
Sulfur (S)	%	1.1	0.9	0.5	0.5

Table 1. Average chemical characteristics of poultry litter and black soldier fly, yellow mealworm, and cricket frass (dry matter basis).

[1]Poultry litter values correspond to the material used in the USDA ARS Booneville, Arkansas, field study. (Amorim et al., 2025)
[2]Frass values represent the average of multiple samples evaluated within each insect group. (Amorim et al., unpublished data)

Benefits of frass as a soil amendment

When applied to soil, frass can serve as a source of plant nutrients. As the material decomposes, nutrients become available for plant uptake. Frass also provides an opportunity to recycle nutrients from food and agricultural byproducts used in insect production back into agricultural soils, supporting more sustainable and regenerative agricultural systems. Beyond supplying nutrients, frass may also affect soil properties and biological activity, which is why it is being evaluated as a soil amendment.

Research also suggests potential benefits related to nutrient-use efficiency, plant growth, plant responses to pests, and higher crop yields. Several of these potential benefits have been evaluated under field conditions in Arkansas.

Findings from Arkansas field studies

Evaluations were conducted at two primary research locations in Arkansas (Table 2). Booneville trials evaluated black soldier fly larvae frass produced by upcycling animal waste and residual byproducts in soybean and switchgrass, with poultry litter included for comparison. Soybean was evaluated under both irrigated and non-irrigated conditions. Fayetteville trials were conducted on bermudagrass and evaluated yellow mealworm frass produced from larvae raised primarily on wheat bran and dried potatoes. Poultry litter and synthetic fertilizer (ammonium nitrate) were included for comparison.

Studies showed that frass can supply plant nutrients, sustain crop yields, improve soil fertility, and provide potential benefits beyond nutrient supply.

Crop yield: Overall, frass maintained crop yields comparable to the other fertilizer sources evaluated. In Booneville, soybean and switchgrass yields were similar among black soldier fly larvae frass applied at 2.5 and 5 tons/acre and poultry litter (2.5 tons/acre). The amendments were applied on an as-is basis (i.e., fresh). Notably, the 2.5 tons/acre frass rate maintained similar yields with lower nutrient inputs than the 5 tons/acre rate and poultry litter, showing a greater nutrient-use efficiency. In Fayetteville, yellow mealworm frass applied at 1.5 and 3 tons/acre (as-is) produced bermudagrass forage yields similar to poultry litter (1.5 tons/acre) and ammonium nitrate.

Plant potassium concentration: In Booneville, switchgrass receiving 5 tons/acre of black soldier fly larvae frass had 25% higher K concentration than the unamended control at the first harvest and was comparable to poultry litter. During the second harvest, switchgrass receiving 2.5 tons/acre had 14% higher K concentration than the control, with K concentra-

Location	Goal	Years of study	Soil type	Frass evaluated	Crops evaluated	Application rates tested	Study
Booneville	Evaluate black soldier fly larvae frass compared with poultry litter, including effects on crop yield, plant nutrient concentrations, pest damage, and soil properties.	2024	Leadvale silt loam	Black soldier fly larvae (3.9% N – 1.3% P – 2.3% K, dry matter basis)	Organic soybeans and switchgrass	Frass: 2.5 and 5 tons/acre Poultry litter: 2.5 tons/acre Control: no amendment	Amorim et al. (2025)
Fayetteville	Evaluate yellow mealworm frass compared with poultry litter and synthetic fertilizer, including effects on yield, plant nutrient concentrations, and soil properties.	2022 – 2023	Captina silt loam	Yellow mealworm (3.4% N – 2.0% P – 2.0% K, dry matter basis)	Bermudagrass	Frass: 1.5 and 3 tons/acre Poultry litter: 1.5 tons/acre Ammonium nitrate: 60 lb N/acre Control: no amendment	Ashworth et al. (2025)

Table 2. Summary of Arkansas field studies evaluating insect frass as a soil amendment.

tions similar among both frass rates (2.5 and 5 tons/acre) and poultry litter (2.5 tons/acre).

Pest damage: In Booneville, black soldier fly larvae frass reduced soybean leaf damage caused by pest insects under both irrigated and non-irrigated conditions. In non-irrigated soybean, frass applied at 5 tons/acre reduced leaf damage by 35% compared with the unamended control. In irrigated soybean, frass applied at 2.5 and 5 tons/acre reduced leaf damage by 31% and 48%, respectively, compared with poultry litter. This was the first field study to demonstrate the potential of frass to enhance plant resistance to pest pressure. The mechanisms responsible for the reduced damage were not evaluated. However, possible explanations include plant responses triggered by chitin, a component found in insect exoskeletons that can activate the plant's natural defenses.

Soil fertility: After two years, yellow mealworm frass applied at 3 tons/acre in the bermudagrass systems resulted in soil N, K, and Mg concentrations that were 12%, 30%, and 35% higher, respectively, than those from poultry litter (1.5 tons/acre). The study also evaluated changes in the total amount of N and C stored in the soil over the two-year period. The increase in soil N stocks was approximately three times greater with frass than with ammonium nitrate, while poultry litter resulted in an intermediate increase. Soil C stocks increased by similar amounts with frass and poultry litter. Despite the improvements in soil organic matter, these changes in soil fertility did not result in differences in overall soil health among fertilizer sources during the two-year study.

Ongoing efforts and next steps

Arkansas research has identified several potential benefits of insect frass, but additional information is needed to guide its use across crops, frass products, and production systems.

Nutrient release: Future research will examine how quickly nutrients become available after frass is applied to the soil. Nutrient release may vary among frass sources and product forms, including pelletized or heat-treated materials. Understanding the timing of nutrient availability is important for matching nutrient release with crop demand and improving fertilizer management.

Certification: Further research is needed to better understand the effects of frass on plant responses to pests and other potential biostimulant effects. This information will be important for determining whether specific frass products could eventually support additional agricultural uses or product claims.

Microbial diversity: Understanding how frass affects soil microbial communities will help determine whether these changes influence nutrient cycling, soil properties, and crop productivity over time.

Application rates and economics: Determining application rates and evaluating the cost-effectiveness of frass compared with poultry litter and commercial fertilizers will help farmers evaluate whether frass is a practical option as it becomes more widely available. These evaluations should consider nutrient availability, transportation and application costs, and potential benefits beyond nutrient supply.

Implications for growers

Arkansas research has identified several potential benefits of insect frass, but additional information is needed to guide its use across crops, frass products, and production systems.

Frass can be an alternative nutrient source: In the Arkansas studies, frass maintained yields comparable to those achieved with poultry litter and other fertilizer sources. It also supplied K to forage crops, which is essential for a plant's ability to handle stress and drought.

Higher application rates may not always provide additional yield benefits: In Booneville, black soldier fly larvae frass applied at 2.5 tons/acre maintained soybean and switchgrass yields comparable to those achieved with frass applied at 5 tons/acre and with poultry litter applied at 2.5 tons/acre, while achieving greater nutrient-use efficiency.

Frass may provide benefits beyond nutrient supply: Reduced soybean leaf damage was observed after black soldier fly larvae frass application, suggesting that frass has some pest repellency properties. Additional research is needed before this benefit can be incorporated into pest-management decisions.

Product analysis is important before application: Frass composition varies across insect species, feedstocks, and production systems. Growers should obtain a nutrient analysis of the specific product before determining application rates.

Frass is an emerging fertilizer option: In Arkansas, frass is currently more expensive and less widely available than poultry litter and commercial fertilizers, limiting its use in large-scale crop production. However, as the insect farming industry expands, frass production is expected to increase. Projections indicate that more than 5 million tons of frass will be produced annually in North America by 2033 (Hénault-Ethier et al., 2024). The nearest commercial insect farms include Midwest Mealworms in Ashland, MO, Fluker's Farms in Port Allen, LA, and Enviroflight in Maysville, KY. Smaller amounts of frass (up to 25 lb) can be purchased online.

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ANA MORALES-ONA SMITH is an assistant professor and Extension soil fertility specialist - Department of Crop, Soil, and Environmental Sciences at the University of Arkansas Division of Agriculture, Harrisburg. **HELEN CARLA AMORIM** is a research scientist - Department of Crop, Soil, and Environmental Sciences at the University of Arkansas Division of Agriculture, Fayetteville. **GERSON DRESCHER** is an assistant professor of soil fertility - Department of Crop, Soil, and Environmental Sciences at the University of Arkansas Division of Agriculture, Fayetteville. **AMANDA ASHWORTH** is a research leader soil scientist with the United States Department of Agriculture - Agricultural Research Service, Fayetteville. **KEITH DRIVER** is a sustainability specialist with Tyson Foods.

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