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Insect Manure (Frass) as a Complementary Fertilizer to Enhance Soil Mineralization Function: Application to Cranberry and Field Crops

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Abstract : Living soil agriculture tries to reconciliate food production while improving soil health, soil biodiversity, soil fertility and more generally attenuating the inherent environmental drawbacks induced by modern agriculture. Using appropriate organic materials as soil amendments has a role to play in the aim of increasing the soil organic matter, improving soil fertility, sequestering carbon, and diminishing the dependence on both mineral fertilizer and pesticides. Insect farming consists in producing insects that can be used as a rich-in-protein and entomo-based food. Usually, detritivores are chosen, thus they can be fed with food wastes, which contributes to circular economy while producing low-carbon food. This process also produces frass, made of insect feces, exuvial material, and non-digested fibrous material, that have valuable fertilizer and biostimulation properties. But frass, used as a sole fertilizer on a crop may be not completely adequate for plants' needs. This is why this project considers black soldier fly (termed BSF, one of the three main insect species grown commercially) frass as a complementary fertilizer, both in organic and in conventional contexts. Three kinds of experiments are made to understand the behaviour of fertilizer treatments based on frass incorporation. Lab-scale mineralization experiments suggest that BSF frass alone mineralizes more slowly than chicken manure alone (CM), but at a ratio of 90% CM-10% BSF frass, the mineralization rate of the mixture is higher than both frass and CM individually. For example, in the 7 days following the fertilization with same nitrogen amount introduced among treatments, around 80% of the nitrogen content supplied through 90% CM-10% BSF frass fertilization is present in the soil under mineral forms, compared to roughly 60% for commercial CM fertilization and 45% with BSF-frass. This suggests that BSF frass contains a more recalcitrant form of organic nitrogen than CM, but also that BSF frass has a highly active microbiota that can increase CM mineralization rate. Consequently, when progressive mineralization is needed, pure BSF-frass may be a consistent option from an agronomic aspect whereas, for specific crops that require spikes of readily available nitrogen sources (like cranberry), fast release 90CM-10BSF frass biofertilizer are more appropriate. Field experiments on cranberry suggests that, indeed, 90CM-10BSF frass is a potent candidate for organic cranberry production, as currently, organic growers rely solely on CM, whose mineralization kinetics are known to imperfectly match plant's needs, which is known to be a major reason that sustains the current yield gap between conventional and organic cranberry sectors.

Keywords : soil mineralization, biofertilizer, BSF-frass, chicken manure, soil functions, nitrogen, soil microbiota
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