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G × E interactions: Larval performance of distinct black soldier fly genotypes grown on different feed substrates

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Black soldier fly (BSF) larvae are considered as promising dietary protein source for aquaculture and poultry feeding, as well as for efficient nutrient recycling through organic waste treatment. Life history performance and body composition of BSF larvae has been shown to be extremely variable, thus hampering predictions of nutritional quality of insect-based feeds and economic performance in general. Feed substrate for BSF larvae is one major driver for the observed variation, as documented in a number of reports. Yet, pronounced differences are still indicated for comparable feed substrates across studies. These have mostly been attributed to different experimental settings whereas potential influences of BSF genetics have largely been neglected, primarily because appropriate genetic monitoring tools have been lacking so far. Building on a global population genetics survey of BSF based on newly developed polymorphic nuclear genetic markers, a fully crossed factorial design was designed to compare performances of four genetically distinct BSF strains grown on three feed substrates with six replicates each. Various growth and compositional traits were determined. Both factors, feed substrate and BSF genetics, as well as the interaction between the two, were found to have a highly significant impact on virtually all investigated life history traits (mortality, growth dynamics, average larval weight) and body compositional characteristics (dry matter, organic matter, crude protein, ether extract) of harvested larvae. The same applied for feed conversion ratio, nitrogen efficiency, degradation of fibre as well as nitrogen and carbon emissions. Frequently detected stronger differences between genotypes within feed substrates than within genotypes across feed substrates show that BSF genetics is key for interpreting and triggering outcomes. However, it can also be inferred that larvae of different genetic origin have different nutritional requirements, further suggesting that optimal feeds may vary across BSF strains, or vice versa, that based on the choice of the latter, different available feeding substrates may be exploited with different success. Our results imply that, depending on targeted objectives for implementing BSF products, efficiency and sustainability of BSF productions may be substantially increased by thoroughly considering BSF genetics and interactive effects with feed substrate composition. Ample indication for BSF genotype-specific effects also provides valuable insights for pinpointed BSF breeding strategies.