agronomy

MDPI

Article

# Nitrogen Fertilizer Equivalence of Black Soldier Fly Frass Fertilizer and Synchrony of Nitrogen Mineralization for Maize Production

**Dennis Beesigamukama [1,2,3], Benson Mochoge [2], Nicholas Korir [2], Martha W. Musyoka [1], Komi K. M. Fiaboe [1,4], Dorothy Nakimbugwe [5], Fathiya M. Khamis [1], Sevgan Subramanian [1], Thomas Dubois [1], Sunday Ekesi [1] and Chrysantus M. Tanga [1,*]**

1 International Centre of Insect Physiology and Ecology, P.O. Box 30772-00100 Nairobi, Kenya; dbeesigamukama@icipe.org (D.B.); mmusyoka@icipe.org (M.W.M.); K.Fiaboe@cgiar.org (K.K.M.F.); fkhamis@icipe.org (F.M.K.); ssubramania@icipe.org (S.S.); tdubois@icipe.org (T.D.); sekesi@icipe.org (S.E.)
2 Department of Agricultural Science and Technology, Kenyatta University, P.O. Box 43844-00100 Nairobi, Kenya; bensonmochoge@gmail.com (B.M.); korir.nicholas@ku.ac.ke (N.K.)
3 Department of Crop Production and Management, Busitema University, P.O. Box 236 Tororo, Uganda
4 International Institute of Tropical Agriculture, B.P. 2008 (Messa), Nkolbisson, Yaoundé, Cameroon
5 Department of Food Technology and Nutrition, School of Food Technology, Nutrition & Bioengineering, Makerere University, P.O. Box 7062 Kampala, Uganda; dnakimbugwe@gmail.com
* Correspondence: ctanga@icipe.org; Tel.: +254-702729931

Received: 6 August 2020; Accepted: 4 September 2020; Published: 15 September 2020


**Abstract:** The use of black soldier fly frass fertilizer (BSFFF) is being promoted globally. However, information on nitrogen (N) fertilizer equivalence (NFE) value and synchrony of N mineralization for crop production remains largely unknown. Comparative studies between BSFFF and commercial organic fertilizer (SAFI) were undertaken under field conditions to determine synchrony of N release for maize uptake. The BSFFF, SAFI, and urea fertilizers were applied at the rates of 0, 30, 60, and 100 kg N $ha^{-1}$. The yield data from urea treated plots were used to determine the NFE of both organic inputs. Results showed that maize from BSFFF treated plots had higher N uptake than that from SAFI treated plots. High N immobilization was observed throughout the active growth stages of maize grown in soil amended with BSFFF, whereas soil treated with SAFI achieved net N release at the silking stage. Up to three times higher negative N fluxes were observed in SAFI amended soils as compared with BSFFF treated plots at the tasseling stage. The BSFFF applied at 30 and 60 kg N $ha^{-1}$ achieved significantly higher NFE than all SAFI treatments. Our findings revealed that BSFFF is a promising and sustainable alternative to SAFI or urea for enhanced maize production.

**Keywords:** frass fertilizer; *Hermertia illucens*; maize; nitrogen fertilizer equivalence; nitrogen mineralization; nitrogen synchrony

## 1. Introduction

Organic fertilizer inputs are one of the promising pathways for sustainably improving soil and crop productivity [1,2]. These organic fertilizers are a good source of nitrogen, which is one of the most limiting soil nutrients for crop production in most parts of sub-Saharan Africa (SSA) [3,4]. Organic fertilizers are an ingredient of stable soil aggregates and are known for improving soil pH, soil organic matter, levels of secondary and micronutrients [2,5–8], as well as nutrient availability, uptake, and utilization [9,10].

Farming systems in countries of SSA rely mostly on inherent soil fertility with very little inputs of mineral fertilizers because of their high costs and unavailability from a local source [11]. Likewise,