

Thesis title: Development of an Azolla-Vermiculite composite fertilizer for enhancing nutrient use efficiency and soil productivity in Uganda

Abstract

The slow-release Azolla-vermiculite composite (AVC) fertilizer is an innovation resulting from a blend of *Azolla cristata* and exfoliated vermiculite. This study identified four species of *Azolla* in Uganda with 100, 93.36, 99.22 and 99.39% sequence identities to the reference database sequences of; *Azolla mexicana*, *Azolla microphylla*, *Azolla filiculoides* and *Azolla cristata*, respectively. These species were distributed in four out of the ten agro-ecological zones of Uganda situated in close vicinity to large water masses. PCA results revealed that maximum rainfall and altitude significantly accounted for the variations in the distribution of *Azolla* with factor loadings of 0.921 and 0.922, respectively. *Azolla cristata*, was selected out of the above four species due to its rapid growth and resilience, and was massively cultivated for developing the AVC fertilizer product.

Exfoliated vermiculite (EV) was used as the carrier in developing AVC fertilizer, since it had better slow release properties as a carrier compared to raw vermiculite (RV). Laboratory analysis of water holding capacity, bulk density, and electro-conductivity indicated a significant difference between EV and RV with p-values of 0.0002, 0.0033, and 0.0002 respectively. Microstructure analysis under SEM exhibited a pure and asbestos free form of vermiculite, that was used in the experiment. XRF exhibited the richness of vermiculite in various minerals including; silica which contributed (>40%) and phosphorus (<1%) among other minerals. Therefore, it was on the basis of these unique properties exhibited by EV, that it was selected for use as a carrier in developing the AVC fertilizer product.

When AVC fertilizer was tested for growth performance, yield and nutritional composition of *Zea mays*, the change in height and yield varied significantly between the AVC fertilizer treated and untreated plants, with p values of <0.003 and <0.001 respectively. Proximate nutrient analysis of starch, reducing sugars, total carbohydrates and pro-vitamin A carotenoids all varied significantly between AVC fertilizer treated and untreated plants with p-values of <0.002. This was attributed to availability of mineral ions from AVC fertilizer that were released in soil for uptake by the plant. The result was enhanced accumulation of photoassimilates in the sink tissues leading to a boost in yield and nutritional composition. In addition, AVC enhanced soil health through increasing soil organic matter which attracted more microbes at the site. Therefore, AVC fertilizer is a promising CSA fertilizer for enhancing soil productivity translating into better food production. As a sustainability measure, there is a need to improve this product so as to achieve its maximum potential in agricultural production. This will serve as a contribution in support of the FAO strategic framework 2021-2030 in the context of Agenda 2030 for sustainable development and Uganda's vision 2040.