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Design and Evaluation of Mechanised Seedball Production for Sahelian Smallholder Farmers

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Abstract

Seedball is a low-cost seed pelleting technique that combines sand, loam, seeds, and optionally wood ash or mineral fertiliser as an additive, in order to enhance the growth of pearl millet or sorghum seedlings in nutrient-poor soil. However, the massive production (10,000 seedballs per hectare) demands time, which poses challenges to Sahelian farmers. Therefore, mechanisation of seedball production is highly required. In this study, a seedball machine prototype was constructed and tested at the University of Hohenheim. The prototype essentially consists of a metal frame and a drum, in which seedballs are formed by an electric motor-powered rotation. It was designed to be easy to construct and operate. Using response surface methodology with a Box-Behnken experimental design, the effect of the prototype settings (substrate composition, rotational speed and residence time) on seedball formation and process efficiency was investigated. As the result, the amount of loam in the raw material composition and the rotational speed of the drum were found to be the most significant factors at $p < 0.05$. The stepwise optimisation led to a production capacity of 44 ± 7 seedballs per minute. Compared to manual production (4 ± 1 seedballs per minute), the prototype performed in a semi-continuous way and was able to reduce the production time by about 92 %. The substrate usage rate was 94.8 ± 3.5 %. The power requirement was about 140 W. The machine-made seedballs were also of high quality. Under greenhouse conditions, the seedballs reached a germination rate higher than 98 %. This study presents the proof of concept for mechanised seedball production that will facilitate the adoption of seedballs by local farmers. As a further step, field tests and demonstrations of the prototype in the Sahel are recommended.

Keywords: Cropping system, cultivation, Frugal innovation, Machine performance, Operation strategy

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