Framework for the genetic improvement of Bambara groundnut: MAGIC populations for ideotype development, genetic and genomic analysis

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\section*{Background information}

\textbf{Bambara groundnut}

- Could impact positively on nutrition, livelihood and economic empowerment within the context of global food security
- Could impact positively on issues of sustainability in the context of agriculture, environment and climate change

\textbf{Constraints}

Despite its potential, Bambara groundnut largely exist as landraces with many constraints (Figure 2).

\subsection*{Major constraints of Bambara groundnut}

- Lack of improved genotypes developed through controlled breeding programme
- Limited understanding of genetics control of important phenotypic traits
- Limited understanding of physiological mechanism underlying phenotypic traits
- Lack of international well coordinated breeding programme

\section*{Bambara groundnut breeding}

\textbf{Breeding objectives}

Primary and secondary sources of information

- Identifying breeding objectives
- Breeding opportunities
- Integrated breeding objectives
- Genetic bottlenecks
- Genotype

\textbf{MAGIC populations}

- Ten genotypes of Bambara groundnut with phenotypic, allelic and geographical origin diversity having the potential to contribute to most of the identified breeding objectives (Figure 3) of the crop have been selected as founder lines to build 8-way MAGIC populations (Table 1; Figure 4).

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{No.} & \textbf{Genotype} & \textbf{Traits} & \textbf{Origin} \\
\hline
1 & Tiga & Cream & Muli \\
2 & DipC & Cream & Botswana \\
3 & IFRA 68F & Dark & Tanzania \\
4 & Unnisa & Red & Swaziland \\
5 & Gotso & Cream & Nigeria \\
6 & 519-3 & Dark & Namibia \\
7 & Lun T & Cream & Sierra Leone \\
8 & DodR & Red & Tanzania \\
9 & AHM & Red & Namibia \\
10 & TAM0873 & Cream & Tanzania \\
\hline
\end{tabular}
\caption{Traits and geographical origin of genotypes selected for MAGIC breeding.}
\end{table}

\section*{Progress & expected outcome}

\textbf{Genetic crosses}

Figure 5A: Day 3 after cross

Figure 5B: Day 3-5 after cross

Figure 5C: Day 10 after cross

\textbf{Impact & expected outcome}

Our proposed conceptual framework of a breeding programme for Bambara groundnut (as an exemplar for the many other underutilized species) focuses on harnessing the potential of the ‘second/next generation’ germplasm resources and specifically MAGIC (Figure 6). The advantage of this approach for genetic improvement of underutilized crop species such as Bambara groundnut is to make efficient use of germplasm resources for variety development coupled with genomic analysis.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure6.png}
\caption{Conceptual framework of germplasm of Bambara groundnut within integrated breeding programmes as a model for the genetic development of other underutilized species.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{The 10 potential genotypes for MAGIC breeding.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{Overview of the major constraints of Bambara groundnut}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Overview of the economic importance of Bambara groundnut}
\end{figure}

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{No.} & \textbf{Genotype} & \textbf{Genetics} \\
\hline
1 & IITA 686 & Single plant descent \\
2 & TAM49 & Single plant descent \\
3 & TAM385 & Single plant descent \\
4 & IITA 107 & Multi generation \\
5 & IITA 1107 & Multi generation \\
6 & IITA 1106 & Multi generation \\
\hline
\end{tabular}
\caption{Names and geographical origin of genotypes selected for MAGIC breeding.}
\end{table}

\section*{References}