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Population hybrid breeding and the use of new statistical tools for sweetpotato

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Abstract

Sweetpotato is a highly heterozygous hybrid, and populations of orange-fleshed sweetpotato (OFSP) have a considerable importance for food security and health. Population hybrid breeding (PHB) has been recently introduced for sweetpotato in the Peruvian, Ugandan, and Mozambican breeding platform by the International Potato Center (CIP). In addition, the transition into PHB was accompanied by intensifying the use of more modern statistical tools for phenotypic data analysis like (generalised) linear mixed models that account for spatial trends in the field. PHB has been studied in the Peruvian breeding platform for a complete reciprocal recurrent selection (RRS) cycle in three OFSP hybrid populations (H1), for which foundation, parents, and hybrids were all evaluated simultaneously at two contrasting locations. The objectives of the study were to estimate heterosis increments and response to selection after one RRS cycle in the three populations. In each H1, the yield and selected quality traits were recorded (for details see Grüneberg et al. (2022); https://doi.org/10.3389/fpls.2022.793904). The data were analysed using modern statistical approaches using mixed models fitted with restricted maximum likelihood (REML), correcting for spatial variation in the field and allowing for heterogeneity of genetic (co)variances in the tested environments. In contrast to previous approaches this leads to unbiased (co)variance estimates and to higher heritabilities because spatial noise is removed from the genetic signal. We observed for storage root yield traits exhibited population average heterosis increments of up to 43.5 %. The storage root yield genetic gain relative to the foundation was remarkably high, ranging from 81.5 % to 132.4 %. In conclusion we argue that PHB is a tool to achieve large genetic gains in sweetpotato yield and most likely other clonally propagated crops, that allows a rapid dissemination of globally true seed that is generated from reproducible elite crosses, thus, avoiding costly and time-consuming virus cleaning of elite clones typically transferred as vegetative plantlets. The transition to more modern statistical tools at CIP was enabled by the Centre for International Migration and Development (CIM), a joint operation of GIZ and the German Federal Employment Agency, by funding the position of plant breeding statistician and resulting capacity building in statistics.

Keywords: Orange-fleshed sweetpotato, population hybrid breeding, reciprocal recurrent selection, restricted maximum likelihood, spatial analysis

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