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Environment-specific selection of high-quality cotton cultivars from on-station and on-farm trials

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Abstract

Selecting qualitatively high cotton cultivars is a critical aspect of cotton breeding programs. However, choosing cultivars is not straightforward. Genotype \times environment ($G \times E$) interactions have to be considered when choosing varieties for cultivation. This holds especially true in organic farming where natural stress resistance is crucial in the absence of genetic modifications.

For on-station trials, GGE biplots have become a popular tool for selecting cultivars. We applied the method to data from our on-station trials conducted at five sites in India and for 29 cotton cultivars. The sites included different farming conditions and the cultivars were a mix of hybrids and non-hybrids from the *Gossypium hirsutum* and *Gossypium arboreum* species. Using the PPBstats package in R, we identified suitable varieties for each site. Cultivar performance varied greatly between sites. Varieties bred at a site performed particularly well, showing the importance of environment-specific breeding.

On-farm trials are a participatory breeding approach that enables farmers to participate directly in the decision-making. However, estimating $G \times E$ effects is difficult due to the trial design. To analyse our on-farm trials conducted on 102 farms in India, testing 32 *G. hirsutum* and *G. arboreum* varieties, we applied a hierarchical Bayesian $G \times E$ model. The analysis was done using the PPBstats package in R. Farm clusters in which the tested cultivars performed similarly were identified. Well-performing varieties for each cluster were found through mean comparisons within each farm. Furthermore, a GGE biplot analysis was performed by pooling farms along agroclimatic zones to identify suitable cultivars on an agroclimatic level. The preliminary results from the GGE biplots have lower precision for the individual farmers that participated in the trials than the hierarchical Bayesian method but can be used for giving recommendations to policymakers and stakeholders for selecting cultivars based on agroclimatic zones. Thus, the combination of the two approaches can be used for decision-making on $G \times E$ cultivar selection through on-farm trials while providing participating farmers with tailored recommendations for their own cultivation.

Keywords: Cultivar selection, genotype by environment interaction, on-farm trials, on-station trials, organic cotton, site-specific breeding