Variation among families and expansion of genetic resources in the Fiji sugarcane breeding program

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Abstract Genetic resources are vital for efficient running of a conventional plant breeding program. In Fiji, numerous efforts had been undertaken to exploit and maintain genetic resources. From 2009-2012, SRIF made half-sib crosses for its breeding program due to absence of proper facilities for controlled full-sib crosses. Results from a trial conducted under a research project (to assess suitability for adoption of family selection method in sugar-producing members of ACP - African Caribbean Pacific Group of States) showed that variation among a sample of 50 of these crosses was not statistically significant for the key traits of pure obtainable cane sugar content (CCS), cane yield and sugar yield (per hectare). As part of the project, a crossing shed was also acquired with provision for controlled bi-parental crosses (via lantern). In other initiatives to increase genetic diversity in the SRIF sugarcane breeding pool, actions were taken to import foreign varieties and continue with introgression of Erianthus arundinaceus. A future priority is to obtain facilities to conduct full-sib crosses and continue germplasm diversification initiatives through importation and introgression breeding.

Key words Genetic resources, varieties, nobilization, introgression

INTRODUCTION

The Fijian breeding program has undergone numerous reviews since its inception in 1904 and has seen changes in the hybridization and selection techniques. Recently, crosses were conducted in an open environment with male and female parent clones tied together on posts 10-15 m apart as well as pollination in plants in the field by hand. According to the late DM Hogarth (pers. comm. 2010), all the crosses conducted in Fiji via above techniques would be termed polycrosses, since it is highly likely pollen contamination from a range of male clones would likely have occurred.

In 2010, a research project was approved via the African Caribbean Pacific Group of States Sugar Research Programme (ACP-SRP) for a comparative study of family and individual mass-selection methods as early selection criteria in ACP sugar-producing countries. During the project, prototype field trials were conducted with Fijian crosses (mostly polycrosses) to understand the process involved before actual inception of project activities that will involve progeny testing from bi-parental crosses. However, analysis of data from prototype trials indicated a lack of statistically significant differences detected in the families used from the crosses, which made selection for best families difficult. We realized that initiatives need to be undertaken to address this to implement family selection. This paper discusses the findings and the initiatives that were undertaken.

MATERIALS AND METHODS

We established a trial with seedlings from 50 polycrosses (families) derived from parental clones from the Sugar Research Institute of Fiji. The families were planted in a randomized complete-block design with four replicates per family. The unit plot had 20 seedlings with 60 cm spacing and row spacing of 1.37 m. Eight stalks (each from a different seedling) were sampled randomly from each family (treatment) in all replicates for juice analysis. All the plots were harvested and weighed to determine cane yield.

Data was analyzed to assess genetic variation in the traits %POCS, cane yield and sugar yields. An analysis of variance (ANOVA) used the Statistix 9 package.
RESULTS AND DISCUSSION

There was no significant difference in any of the traits among the families (%POCS $F_{49,144} = 1.19$, $P = 0.21$; cane yield $F_{49,147} = 0.93$, $P = 0.61$; $F_{49,147} = 1.13$, $P = 0.29$). This result indicates that it would be not be possible to confidently discriminate among the families based on such data. One explanation could be a lack of genetic diversity in the parent pool.

Arising from this, we initiated germplasm exchange via importation of clones and fuzz, and initiated introgression crosses. We have imported 52 cultivars from MSIRI in Mauritius, SRA in Australia and SRI in Vietnam and 42 of these are already in the breeding plots and have been used in the sugarcane crosses in the last 2 years. Fuzz from the West Indies breeding program was sown in 2012 and 2013 and the germinated seedlings have been used in the ACP-SRP project which is ongoing. Excess seedlings will undergo routine selection for inclusion in the breeding plots.

Introgression work with Erianthus arundinaceus was initiated by the late Dr. Krishnamurthi and became part of another ACP-SRP funded project. Historically, a major effort on introgression breeding was conducted in the Fiji cane breeding program, mostly with S. spontaneum, in 1960 to early 1990 (Daniels et al. 1965; Brown et al. 1969; Krishnamurthi et al. 1980) and some derivatives from that program are still available. The results of an extensive review and restoration of existing germplasm were published by Singh et al (2012). While this activity is still being pursued by SRIF, no success has yet been achieved in terms of attaining ‘true’ hybrids involving Erianthus. For this reason, expertise of international scientists involved in Erianthus introgression was sought via a workshop conducted in Fiji following which a few recommendations have been adopted to improve introgression methods.

A second explanation for lack of significant variation among families is that variation between polycrosses (with half-sib progeny within each family) is less than variation between bi-parental crosses (with full-sib progeny within each family). Thus family selection may be more effective with full-sib crosses than with polycrosses. It is planned to make and assess bi-parental (full-sib) crosses in future.

The findings from the project will be reported after the project completion in next 2-3 years’ time.

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REFERENCES


REFERENCES


La variation entre les familles et l’expansion des ressources génétiques dans le programme d’amélioration variétale de la canne à sucre aux Fidji

(ACP), démontrent que la variation parmi un échantillon de 50 croisements n’était pas statistiquement significative pour les caractéristiques majeures suivantes: la richesse saccharine (CCS), rendements en canne et en sucre par hectare ainsi que l’extraction. Dans le cadre du projet, une serre a également été construite pour procéder à des croisements biparentaux sous des conditions contrôlées dans des lanternes. Dans la même foulée d’accroître la diversité génétique dans le germoplasme du SRIF, des mesures ont été prises pour importer des variétés étrangères et continuer avec le programme d’introgression de *Erianthus arundinaceus*. Une des priorités pour l’avenir est d’obtenir les infrastructures nécessaires pour effectuer des croisements biparentaux et de poursuivre les initiatives de diversification du germoplasme à travers l’échange variétale et l’introgression des caractéristiques ciblés.

**Mots-clés:** Ressources génétique, variétés, nobilization, introgression

Variación entre familias y expansión de los recursos genéticos en el programa de mejoramiento de caña de azúcar de Fiji

**Resumen.** Los recursos genéticos son vitales para la buena marcha de un programa de fitomejoramiento convencional. En Fiji, numerosos esfuerzos se han emprendido para explotar y mantener los recursos genéticos. A partir de 2009-2012, el SRIF hizo cruzamientos de medios hermanos para su programa de mejoramiento debido a la falta de instalaciones adecuadas para realizar cruzamientos controlados de hermanos completos. Los resultados de un ensayo realizado dentro de un proyecto de investigación (para evaluar la idoneidad de la adopción del método de selección familiar en los miembros productores de azúcar de ACP – grupo de estados de África y Caribe) mostró que la variación entre una muestra de 50 de estos cruces no fue estadísticamente significativa para las características fundamentales del contenido de azúcar de caña pura obtenible (CCS), la producción de caña y rendimiento de azúcar (por hectárea). Como parte del proyecto, se adquirió una casa de cruzamientos con equipamiento para realizar cruces biparentales controlados (vía toldos). En otras iniciativas para aumentar la diversidad genética germoplasma de caña de azúcar del SRIF, se tomaron medidas para importar variedades extranjeras y continuar con la introgresión de *Erianthus arundinaceus*. Una prioridad a futuro es obtener facilidades para llevar a cabo cruces hermanos completos y continuar con las iniciativas de diversificación de germoplasma a través de la importación y mejoramiento por introgresión.

**Palabras clave:** Recursos genéticos, variedades, nobilización, introgresión