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- Programme
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ABSTRACTS

SUGARCANE THROUGH THE CENTURIES

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Since the barbarian times it is mentioned in the literature that sugar cane was used by their warriors, and that the discovering expeditions of Spain and Portugal would carry sugarcane in their vessels to avoid scurvy in their sailors. However, the history and manipulation of sugar cane didn't change only in the late 1800´s, when Soltwedel in Barbados and breeders of Java discovered that plants could produce viable seedlings. At the time only the domesticated old Saccharum sinensis, known as Uba, Saccharum officinarum as Badila and other varieties were used as raw matter, but they were soon after replaced by hybrids that were much more productive.

Yield improvement through breeding tends to be confused with improvements in cultural practices. For example, yield improvement are often attributed to fertilization, and other practices rather than to new varieties. On the contrary, if there is a decrease in yield or bad management the variety is blamed for. Unofficial rule maintaining variety areas lower than 20-25% due to the risk of new diseases has been neglected due to a high profitability of some varieties. Examples of this are LCP85-384 in Louisiana, the CP72-2086 in Central America, Ragnar in Ecuador and Panama, and R570 in the French Islands.

Countries and institutions that do not have a breeding program are totally dependent on introduced varieties. Most of them are already difficult to acquire due to the Intellectual Property Rights (IPR) given by the countries to their varieties. Although there are still some programs that share their varieties in terms of membership or agreements, because of the IPRs, in the future each group of mills might have their own breeding program to suit their needs. However, each day new challenges occur and selection has to be updated for these new traits, such as biomass, fiber content, ethanol, resistance to new diseases and pests, mechanical harvest, plant physiology adapted to climate change, irrigation techniques and sucrose enhancement.

Breeding programs have successfully used new tools for family selection and mechanically harvested trials. The use of genetic engineering to deal with undesirable traits has been successful in sugarcane although its use is still prohibited in several countries. The situation is different for sugar beet, which resulted in big increases in sucrose content since 1980. It has been reported that that 169 sugar beet varieties were released from Genetically Modified Crop Plants in the European Community.

Biotechnology in sugarcane had a breakthrough with the DNA sequencing of the Sugarcane Genome Project. More than 200 scientists from 22 Brazilian research groups were involved in this study since 1998. Researchers have shown that at least 2,000 of the 33,000 genes are associated with sugar production in the plant. Today's research is focused on establishing correlations with the crop traits and these genes in at least 48 Brazilian different laboratories.

From the spread of sugarcane to several locations of the world where no cane was planted before, it is clear that new challenges to develop new varieties are needed that respond to different environments. Therefore, sugarcane variety research is still the basis for any program interested in better yields and sugar content.

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GENETIC DIVERSITY IN A LARGE COLLECTION OF *Saccharum spontaneum*

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Leaf material from 440 Saccharum spontaneum clones was assembled for DNA extraction and genetic diversity analysis using AFLPs. The leaf material was sourced from the germplasm collections in Australia (Australian Germplasm Resource Centre, Meringa BSES Limited), Brazil (CTC, Copersucar), China (YSRI of Yunnan Academy of Agricultural Sciences) and USA (ISSCT world collection, USDA-ARS). In summary, 159 clones were sampled in Brazil, 140 in USA, 89 in Australia, and 48 in China. Three AFLP primer combinations were used to generate 730 markers, all of which were polymorphic across the population, a reflection of the high level of diversity in this collection. Almost 50% of the markers were present in only 10% of the collection. Principal Component Analysis was conducted on the resulting binary matrix. The first component explained 12.6% of the variation the second 2.4 % and the third 1.7%. Two weak clusters were identified, one containing clones collected from southern India and Indonesia, and the second cluster containing clones collected from northern India and China. There was no apparent clustering based on chromosome number, although this could be a reflection of the paucity of available chromosome numbers in this species. Future analyses will be aimed at further examination of the genetic diversity within the two major clusters, and a comparison of the diversity

within this collection and core breeding populations. These results will be useful for future sampling of S. spontaneum material for germplasm conservation and introgression breeding.

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IDENTIFICATION AND CHARACTERIZATION OF INTERGENERIC HYBRIDS OF SUGARCANE(*Saccharum spp.*) AND RELATIVES

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In recent years, achieving higher biomass production and wider adaptation to environmental conditions have been the goals of sugarcane breeding. To introgress useful traits, such as high ratooning ability and drought tolerance, intergeneric hybridization between commercial sugarcane (Saccharum spp.) and Erianthus arundinaceus (Retz.) Jeswiet was attempted. Commercial sugarcane NiF 8 and Ni 9 were used as female parents, and E. arundinaceus clone IJ 76-349 and IK 76-126 were used as male parents. Intergeneric hybrids were identified by the 5S rDNA electrophoresis pattern of PCR products. Cell nuclei of intergeneric hybrids and parents were stained by PI (Propidium iodide) and measured by flow cytometer. One hybrid was clonally propagated in Wagner pots and measured brix.

In total, five hybrids were obtained from 173 seeds, three were from crosses NiF 8 x IK 76-126 (three hybrids from 130 seeds), and one each was from crosses NiF 8 x IJ 76-349 (one from 42) and Ni 9 x IJ 76-349 (one from one), respectively. DNA contents of hybrids showed approximately the sum of half of the DNA content of both parents, suggesting hybrids were derived from n+n chromosome transmission. Morphological characteristics, for instance tillers and existence of ligule, differed between hybrids, Hybrid obtained from Ni 9 x IJ 76-349 showed similar brix compared to Ni9. These results indicated that hybrids would be worth using for the breeding program. Further studies, such as chromosome constitution, flowering behavior and efficiency of hybrid production affected by (depending on) genotype, are essential for improving intergeneric hybridization.

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MICROSATELLITE-BASED PATERNITY ANALYSIS OF A SEVEN-PARENT SUGARCANE POLYCROSS.

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It is virtually impossible to make all cross combinations among even the most elite parents used in breeding programs. Hence, the polycross approach has been used in sugarcane breeding to maximize the number of cross combinations that could be represented among progeny at the seedling stage of testing. The primary objection to using the polycross approach has been the rapid loss of pedigree information that occurs over generations of breeding. Microsatellite-based paternity analysis is proposed as an effective means for identifying the male parentage of progeny resulting from small polycrosses. We provide a preliminary report on our experience in analyzing a polycross involving seven parents. The two microsatellite markers that produced the greatest number of polymorphic fragments or alleles, namely SMC336BS and SMC597CS, were used to genotype a sample of 87 progeny from each female parent. We used 96-well plates which consisted of the 87 progeny, the seven parents plus positive and negative controls. The two markers produced ten (9 polymorphic) and eleven (10 polymorphic) alleles, respectively. These 19 discriminating alleles allowed us to positively identify the male parentage of 51% (ranging from 35-70% depending on the female parent) of the progeny from this polycross and to obtain a workable estimate of the relative pollen contribution of each male parent per female parent used in the polycross. Estimated contribution of the most dominant male ranged from 14 - 53% across female parents. Small polycrosses accompanied with microsatellite marker genotyping technology can be used in a sugarcane breeding program to maximize desired parental combinations at a minimal loss in parental information.

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PROGRESS AND PLANS IN APPLYING DNA MARKERS TO SUGARCANE BREEDING PROGRAMS IN AUSTRALIA

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In Australia we are applying and exploring the use of DNA markers in sugarcane breeding programs in a range of ways. DNA markers are used routinely for clone identification and checking, and for verification of parentage of clones. The latter application has been especially valuable in verifying parentage of F1 and backcross progeny derived from wild clones, particularly from Erianthus.

Markers have been used to characterise the genetic diversity within basic germplasm collections and the Australian commercial sugarcane breeding program. This information may be used to help identify clones with significant new genetic diversity for future introgression breeding, and develop ways to better exploit existing genetic diversity.

Research and pilot scale programs are underway in developing and testing marker assisted selection and breeding applications. There are three approaches being evaluated: (i) Marker assisted selection within many-parent populations routinely generated in early stage selection trials core breeding programs, relying on residual linkage disequilibrium for marker-QTL associations. (ii) Improvement of high value bi-parental populations based on QTL mapping followed by recombination of the male parent genome through selfing and selection among recombinants. (iii) Marker assisted introgression of wild germplasm.

In area (i) a pilot study characterising 154 clones (parents and advanced stage selections) with about 1500 markers found

significant associations between markers and resistance to four different diseases. Most of these associations did not appear to be due to population structure effects, suggesting durable associations due to marker-QTL linkage. These promising results led to the design of a larger experiment with a larger number of clones and markers which is currently underway. This experiment has been designed so that positive results from this experiment could lead to direct implementation of marker assisted selection in core breeding programs.

Programs in area (ii) and (iii) are currently being done through several case study programs but it is too early yet to know if these proposed approaches will help significantly in developing new cultivars. Work in area (iii) is being done in collaboration with institutes in China and targeting use of Erianthus arundinaceus and S. spontaneum. Approaches being taken in all areas and some key results to date will be briefly described.

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SIGNIFICANCE OF INDUCED MUTATION COMBINED WITH GAMMA RAYS AND CELL CULTURE TECHNIQUES IN SUGARCANE

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Effects of acute and chronic gamma rays irradiations were compared using in vitro culture on inducing the mutation of regenerated clonal lines in sugarcane. Radiation breeding has yielded excellent results and is still developing as indispensable tool to improve varieties in many plants. So far, a number of radiations, beta ray, gamma rays, x-rays, neutron and so on have been investigated for mutation induction of plant species, ionized radiation, that is, gamma rays, x-rays has been utilized almost 80 % of the registered mutant varieties in the world.

There are two streams of gamma irradiation methods, acute and chronic irradiations. In the former case, acute irradiation facilities such as gamma room and gamma cell have been extensively operated treating with smaller materials like seeds, bulbs, tubers, scions, spores. In the latter, chronic irradiation facilities such as gamma field and gamma greenhouse have been utilized dealing with a large quantity of plant materials or big materials under low dose rates in the growing condition.

In sugarcane, the regenerated populations from chronically irradiated plants showed rather wider variation than ones from non-irradiated. The ranges of variation extended not only in a negative but also in a positive direction. On the other hand, the means of major characters were decreased remarkably as the irradiation dose rose.

Average chromosome numbers estimated by DNA content show remarkable trend by irradiation methods. Regenerated lines from unirradiated plants show the same chromosome number as the original variety estimated for 2n = ca. 116. In acute irradiation, regenerated mutant lines show remarkable decline of chromosome numbers as the irradiation dose roses. There is close negative correlation between irradiation dose and chromosome number of each mutant lines. On the contrary, in chronic irradiation, regenerated mutant lines indicate generally little decrease in chromosome number. It is a proper indicator to monitor radiation damage.

From the present study, it is evident that gamma irradiation plus tissue culture is a method of extending variation and increasing mutation frequency.

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OPTIMIZATION OF DAY-LENGTH DECREMENT AND COMMENCEMENT OF INITIATION FOR SYNCHRONIZATION OF TROPICAL SUGARCANE FLOWERING

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Panicle delivery in the photoperiod facilities (PFs) at BSES Meringa is successful. In 2003, clones delivering panicles ranged from 77.3 to 85.2% (PF(A)) and 77.3 to 93.8% (PF(B)). Percent stalks delivering panicles ranged from 59.4 to 68.0% and 64.9 to 78.6%, respectively. Combinations made were 461 and 453, respectively. Improved performance is desirable as the facilities are expensive and their outputs are increasingly important to BSES's crop improvement programs.

Research focused on optimizing day-length reduction for panicle initiation and development rather than treating flowering as a single-stage process subjected to a single photoperiod. Panicle delivery in PF(B) in 2003 took 50 days (commencing day length 12 h 55 min; decrement 45 s d-1). Treated populations have not been partitioned into early-, mid-, and late-flowering clones and subjected to staggered commencement dates to shorten panicle delivery.

Plants were grown and managed using published techniques. In PF(A) and PF(B) in 2004 decrements of 30, 45, and 60 s d-1 were started on 1, 17, and 28 April, respectively. For PF(A) and PF(B), there was no within-chamber replication, but three and four standard clones, respectively, were repeated on each of the four trolleys per chamber. In 2005, the same decrements were used and started on 1 and 23 April and 5 May, respectively. The changes were based on the 2004 results. In PF(A), there was no replication, but there were four standard clones per trolley. In PF(B), replication was confounded with pot size, clones being either in 1 x 33 L pots/replicate, with three single stalks, or 4 x 6 L pots (155 mm square x 240 mm high)/replicate, with a single stalk.

In 2004 flowering was excellent, with no significant differences among chambers for percent flowered stalks in PF(A). There were in PF(B). This was caused by an artifact. There were differences in timing. Flowering stalks ranged from 75 to 80% and 63 to 82% in

PF(A) and PF(B), respectively. Flowering clones ranged from 85to 89% and 84 to 92%, respectively. In 2005, flowering was reduced. There were highly significant differences among chambers in PF(A), with 45 s d-1 the best (69.5 vs 52.2 and 55.0%). In PF(B), treatments did not differ (67.1, 62.7, and 42.9, respectively). There were significant differences among pot sizes.

Data suggest a decrement of 45 s d-1 is best. Optimization of synchronization to allow compression of cross-pollination is incomplete but will be addressed in 2006 experiments.

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CHANGES BEING CONSIDERED IN THE EARLY STAGES OF THE SASRI SELECTION PROGRAM

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Plant breeding programs need to be constantly monitored to ensure that current strategies and procedures are operating at optimal levels. Pressure to change strategies and procedures can come from within an organization or from external sources and can be viewed as a threat or an opportunity. Opportunities would generally be considered as new technologies and information, while threats could include limited resources (finances, skills, equipment) and political issues in the industry, country or globally. Plant breeders will mostly make the changes to breeding strategies and procedures to effectively deal with these pressures.

The South African Sugarcane Research Institute conducts a regional breeding and selection program. In 1997 six main regions were identified with the view to selecting varieties better adapted to the diverse conditions existing within the South African sugarcane belt. Research stations were acquired and a five-stage selection program initiated in each region. The selection strategy put into practice in each region were very similar to start, however, as the knowledge of the regions has increased over the years a number of changes have been made and are being considered. In recent years, a number of external pressures have also been encountered requiring strategies and procedures to be reviewed.

The presentation covers changes that have been made, as well as changes that are being considered in the early stages of the SASRI selection program. Results from retrospective analysis will also be discussed.

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PROGRESS IN SELECTION FOR CANE YIELD AND SUCROSE CONTENT IN ECUADOR.

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A clonal selection program was started in 1998 with the objective to develop improved varieties, with high sucrose content and cane tonnage to complement or even replace Ragnar, which is the leading variety in Ecuador covering more than 74% of the total cultivated area. The first five selection series (1998 - 2002) were initiated with crosses made in COPERSUCAR-Brazil, Canal Point-USA, and BSES-Australia. In 2003, our own photoperiod and crossing facilities started to operate. Local crosses yielded many families from Stage I with high sucrose content as compared to Ragnar. These results showed that selecting parents and managing local crosses increased the probability to obtain superior genotypes which might become the new improved varieties for Ecuador.

There are many advanced clones from series 1998, 1999, and 2000 being evaluated at different location and ratoons, with cane tonnage and sucrose content superior to those of Ragnar. In series 1998, clones ECSP98-127, ECSP98-149 and ECSP98-169 showed averages of total sugar production over three ratoons of 7.7, 7.7 and 9.2 tones of sugar per hectare (TSH), respectively, compared to Ragnar with 7.2 TSH. These promising clones are evaluated in semi-commercial trials, including their response to fertilization. The results of these experiments will help to decide on the first release of Ecuadorian varieties.

Keywords: Selection, sucrose content, improved varieties.

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UTILIZATION OF WILD RELATIVES IN SUGARCANE BREEDING PROGRAM IN JAPAN

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Sugarcane is promised as the good biomass resource for multipurpose use such as sugar, ethanol, fiber and fodder. However, it is difficult to perform their high biomass productivity under adverse conditions such as typhoon, drought and poor soil fertility. KONARC have been attempted wide crossing to overcome unstable yield influenced by adverse conditions, and to improve aimed products.

In this program, S. spontaneum that collected in Japan and introduced from some foreign countries were used. KRFo93-1, a cross from sugarcane and S. spontaneum, showed excellent ratooning ability, and it was released as a first variety for the fodder. Many F1 and BC1 clones from crosses between sugarcane and S. spontaneum that have good performance in yield, good growth under adverse conditions will be candidate for promising lines. The problems in this program are that most of utilized genetic resources are susceptible to smut. Now, we carry on the smut tolerant screening, and try to utilize more wide crossing materials.

In utilization of S. robustum, 107 plants were obtained from crosses between sugarcane and S. robustum, have vigor and high fiber contents. These are under the selection stage, will be utilized as crossing materials for fiber production plants. In this case, the problem is that utilized genetic resources are very few caused by rare heading.

To introduce deep root system and vigor, many crossing have been carried on between sugarcane and Erianthus spp., and some progenies were obtained. These were under the selection stage, and some clones were clarified their hibridity by authors. Morphological characteristic and yields etc. will be evaluated. In contrast to utilization of S. spontaneum and S. robustum, very few hybrids were obtained from sugarcane and Erianthus spp. crosses. To clarify the conditions for successful hybridization, to develop the efficient crossing procedure between sugarcane and Erianthus spp., further studies such as flowering behavior, optimal humidity to maintain pollen germination ability and pollen preservation are essential for improving intergeneric hybridization between sugarcane and Erianthus spp.

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VARIETY SELECTION TO INCREASE SUCROSE CONTENT UNDER LESS FAVORABLE ENVIRONMENTAL CONDITIONS IN THE CAUCA RIVER VALLEY, COLOMBIA

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Sugarcane is harvested year-round in the Cauca river valley in Colombia. Climatic conditions (rainfall, relative humidity) prior to harvesting during the first semester are unfavorable and adversely affect the sucrose content of sugarcane thus affecting sugar production. The contrary is observed during the second semester when the weather is milder. CENICAÑA's Variety Improvement Program therefore aims to develop varieties with a high sucrose content, yielding good TSH.

Clones of the F1 generation of 24 crosses of the CC '92' series, 20 crosses of the CC '93' series, and 2 crosses of the CC '94' series were accordingly selected during both semesters, from selection stages I to III. The best clones of the '92' series were evaluated in a regional trial during Semester A of 2000. The sucrose content of clones selected in previous stages during Semester A was 7% higher than the check variety MZC 74-275, whereas the sucrose content of the clones selected in Semester B was 3% higher than the check variety but lower than those selected in Semester A. The best clones of the '93' and '94' series were evaluated in a regional trial held during Semester B of 2000. The sucrose content of the clones selected in previous stages in Semester A was similar, and several were superior to that of the check variety. Clones selected in previous stages in Semester B presented a sucrose content 3% higher than that of the check, suggesting that selection in Semester A helped advance in the search for increased sucrose content as compared with that performed in Semester B.

The results of the different series of selections indicated greater efficiency in selection for sucrose content during Semester A. Varieties were therefore selected during that semester. In addition to high sucrose content, to become commercial varieties the selected clones must also show good agronomic traits. Clones such as CC 92-2198, CC 93-3826, and CC 93-3895, which were screened and selected during Semester A, are now alternative varieties to the leading variety CC 85-92 in the Cauca river valley. CC 93-3895 yielded 1.62 TSHM in a semi-commercial trial, corresponding to an additional 120 KSHM as compared with the commercial control CC 85-92.

Keywords: sugarcane, sucrose content, breeding.

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A PRACTICAL METHOD FOR THE EARLY ASSESSMENT OF THE VALUE OF SUGARCANE CROSSES IN GENERATING POTENTIALLY ELITE GENOTYPES FOR SELECTION

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Replicated cross evaluation trials have traditionally been laid down with potted seedlings that are transplanted in the fields. Since 2004, the policy of transplanting 50% of the total seedlings produced each year directly in the field at high density, without prior potting, was implemented as a means to reduce on resources. This study investigates the feasibility of applying cross evaluation techniques on seedlings transplanted in this way based on random samples of 81 seedlings from 26 crosses in order to derive quick information on the value of crosses and parents in producing elite genotypes. Seedlings were planted in three replicates on raised beds of size 8m x 1.5m, in three rows and spaced at 0.40m between seedlings. Ten months after planting, stalk number, stalk diameter and stalk height were measured on five stalks per 20 progeny within each replicate. Genotypes selected from each family were evaluated at the 1st clonal stage and selection rate was appraised on field Brix, vigour and visual grade.

Three univariate cross prediction methods were examined, the predicted proportion of genotypes that transgress set target values (PROB), the observed proportion of genotypes that transgress the target (OBS) and the mean of family (MEAN). Multivariate methods were based on the sum of ranks (RANK) and the frequency of genotypes that transgress set targets simultaneously (FREQ). Families differed significantly for all characters and between family variance was much more important than the within family variance. Narrow-sense heritability estimates, were very low for stalk number (0.11) and moderately low for stalk diameter (0.25) and stalk height (0.27), implying high environmental variation. The three univariate predictive statistics were equally robust in identifying the best crosses for all three characters with significant correlation between PROB and OBS (r = 0.90 - 0.96), MEAN and PROB (r = 0.97 - 0.99) and MEAN and OBS
(r = 0.89 - 0.95). Highly significant correlation between the RANK and FREQ statistics were obtained for multivariate combinations of characters (r = -0.58 to -0.70).

In general, the "better" crosses (top 50%), based on frequency (%) of elite genotypes and ranking, gave significantly higher selection rates (28% to 50%) at the seedling stage compared with lower potential ones. In general, crosses that gave the highest selection rates at the seedling stage also produced high selection rates at the 1st clonal stage. The MEAN and RANK methods are

simple and reliable statistics that could be used in determining the best crosses even when seedlings are transplanted densely in the fields. A scenario for evaluating a large number of crosses quickly within the routine selection program is discussed.

Keywords: Cross prediction, high density, heritability, seedlings, selection, univariate and multivariate statistics.

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THE CENTRAL ROMANA BREEDING PROGRAM: FIFTY YEARS OF EXPERIENCE OF A PRIVATE EFFORT FOR THE DEVELOPMENT OF SUGARCANE VARIETIES.

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Central Romana Corporation Limited is a private corporation operating in the Dominican Republic the largest sugar cane mill in the Caribbean basin. Cane supply is almost entirely dependent on the cultivation of varieties originating from its own sugarcane breeding program. This program was initiated in 1957 with parental clones obtained from the World Collection, in Canal Point, Florida. It's aimed at developing sugarcane varieties adapted to its rather marginal growing conditions and prolonged ratoon cycles. In addition to its own 70,000 seedlings grown every year, Central Romana has maintained an agreement with the Central Cane Breeding Station (Barbados) through which about 30,000 seedlings are evaluated yearly.

Despite the natural constraints imposed, among other factors, by the limited flowering within the active breeding collection and the traditionally reduced pollen shedding, during these 50 years of experience the program has screened about 5.5 million seedlings, tested more than 12,000 clones and released 20 commercial varieties. This paper discusses the main developments as well as the rationality behind the changes lately introduced to yield a more sophisticated and efficient selection scheme, as a result of both local and other industries's experiences. Based on a proven crop * soil interaction the program has been segregated for the main three soil groups; family selection is a routine within two of the sub testing sites; a new greenhouse has improved seedling recovery and vigor; selection in ratoon crops along with the early decentralization and a more objective clonal assessment have yielded to a shorter testing cycle; and generation interval is within 5 - 6 years. In near future the program, now moving to its fourth generation of clones, faces the challenges of selecting for an increasing mechanical harvesting scenario, improved yields to sustain an economically healthy business in a more competitive industry, improved levels of trial prediction, release of more stable cultivars, and avoidance of inefficiency due to a narrow genetic diversity of parents. Central Romana presently grows its local varieties in more than 95 % of the cane areas, stands behind applied R&D by confidently investing in these activities and still actively supporting one of the few private sugar cane breeding in the world.

Keywords: Sugarcane breeding, soil interaction, family selection.

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RELATIVE ECONOMIC EFFECT OF SOME PEST, DISEASE AND HARVEST TRAITS ON VARIETY VALUE: PRIORITISING NON-YIELD TRAITS FOR BREEDING AND SELECTION

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When candidate varieties are considered for commercial release, a number of traits in addition to sucrose yield and sucrose content need to be taken into account when assessing the candidates potential suitability. Resistance to important pests and diseases are key criteria, as well as agronomic traits such as erectness, lodging, flowering etc., which impact on farming production costs and possible yield losses. In order to make objective release decisions, all of these factors must be compared.

For pests and diseases measured in replicated or designed inoculation trials, viz. eldana stalk borer, smut and sugarcane mosaic virus, a method of assigning rating based on the trial statistics has been implemented, in order to standardise the rating method where possible. By analysing trial statistics across seasons, functions have been derived whereby ratings can be standardised for any level of damage observed. Using published data from the literature, ratings can be converted into potential yield loss and be given an economic value, allowing different traits to be compared on the same scale. Results show that as the different pest and disease measurements have different statistical distributions and phenotypic variances, some adjustment of rating is required to make them comparable.

In addition, agronomic traits can also be assigned an economic value based on their contribution to potential yield loss, allowing direct comparison with pest and disease traits. One of the current shortcomings in routine data collection is the lack of an objective rating system for traits such as lodging and straightness that can be used to derive yield-loss functions for these characters. In addition, disease traits such as rust and gumming that are rated in the field and not subject to statistical analysis will not be measured on the same relative scale. This needs to be considered when variety promotion and release decisions are made. Ultimately, measurement methods should be developed in order to correct this shortcoming.

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FAMILY X ENVIRONMENT INTERACTION IN SUGARCANE IN GUADELOUPE.

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An experiment on 21 families was performed in two contrasted environments in Guadeloupe (one in a vertisol area with small rainfall level and the second one in a feralitic soil with much higher rainfall level) in order (i) to assess family x environment interaction, and (ii) to estimate to which extent the varietal development program needs to be located in several environments.

Both trails consisted of alpha-plan design comprising 28 seedlings per family, 3 replicates and 3 blocks/rep. and seven families per block. Stalk diameter (SD), stalk length (SL), brix (BX), stalk number (SN) and cane weight (CW) were recorded.

An ANOVA has been performed within each site and considering both sites together. A good control of environmental error was observed as standard variation ranged from 3 to 15%, depending on trait. All characters showed a highly significant family effect across both sites (P < 0,001). A highly significant family x environment interaction effect was observed (P < 0,001) for SN but not for other traits. These results are discussed regarding the family sample size, the number of families and the number of environments surveyed.

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BREEDING FOR RATOON STUNT RESISTANCE AT CANAL POINT, FLORIDA

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Ratoon stunt is a major disease of sugarcane caused by Leifsonia xyli subsp. xyli (Lxx) that has traditionally been controlled using thermal therapy and phytosanitary procedures. Variable success has been obtained by stringent quality of phytosanitary procedures in susceptible cultivars due to the high spread of Lxx. In order to develop resistance as a means to assist in the control of the disease, the Canal Point (CP) cultivar development program began screening clones for ratoon stunt resistance 14 years ago. Knowledge of the ratoon stunt reaction prevented the crossing of two susceptible parents.

Furthermore, clones are tested in separate trials in a un-replicated-inoculated test at the first yield trial stage and in replicated tests for clones carried through the selection program. Ratoon stunt reaction is based on a tissue blot immunoassay that determines the number of Lxx colonized vascular bundles (CVB). Clones with the higher average CVB number show higher susceptibility. Although there is limited selection pressure to discard susceptible clones, there has been progress in producing resistant cultivars. Prior to the initiation of the screening program, the three major commercial CP cultivars were susceptible with greater than 7.75 CVB.

Currently, the clones in the final testing stage (Stage IV) averaged 4.0 CVB and the average number of CVB was 5.1 for the 881 clones in Stage II. The following aspects of the screening program will be discussed: the logic for developing ratoon stunt resistance, methodology and procedures, progress made, resources required, and usefulness in controlling disease.

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'LCP 85-384' - THE RISE AND FALL OF A MONOCULTURE.

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The release of LCP 85-384 was a major milestone for Louisiana sugarcane breeding efforts. The new variety was released in 1993 by the LSU AgCenter in cooperation with the USDA-ARS and the American Sugar Cane League. Yield data upon release to Louisiana's growers provided overwhelming evidence that LCP 85-384 had superior sugar yields, approximately 20% greater than the currently grown varieties at that time. The variety also possessed excellent resistance to many of Louisiana's major sugarcane diseases that include Sorghum mosaic virus, brown rust (Puccinia melanocephala H. & P. Sydow), smut (Ustilago scitaminea H. & P. Sydow), and leaf scald [Xanthomonas albilineans (Ashby) Dowson]. The main weaknesses of LCP 85-384 were its propensity to lodge and its susceptibility to the sugarcane borer [Diatraea saccharalis (F.)], which were overcome by a switch to combine harvesting and the use of insecticides, respectively.

LCP 85-384 was quickly expanded in acreage upon its release. In 1998, it became the most widely grown sugarcane variety in Louisiana when it occupied 43% of the state's acreage. Its majority status continued with its peak of planted acreage occurring in 2004 when LCP 85-384 occupied 91% of Louisiana's sugarcane acreage. With slim profit margins, growers were not willing to diversify much acreage with other lower yielding sugarcane varieties.

Beginning in 2000, brown rust was first seen in the once resistant variety. In each subsequent year, increasing amounts of brown rust were observed in LCP 85-384. Yield loss assessments in 2004 and 2005 conducted by plant pathologists indicated cane yield decreases of 11 to 16 Mg/ha. Concurrently, Louisiana sugar production dropped dramatically due to the combined effects of hurricanes and the yield decline observed in LCP 85-384.

Breeding efforts to develop comparable varieties were at first hindered by the initial success of LCP 85-384. Not many experimental clones in the program could produce similar yields. HoCP 91-555 was released in 1999 but had little impact. In 2003, HoCP 96-540 was released, and this was followed with the release of L 97-128 and Ho 95-988 in 2004. Both HoCP 96-540 and L 97-128 have been expanded rapidly to replace LCP 85-384. These two varieties have exhibited excellent sugar yield potential, are less likely to lodge, and have greater resistance to brown rust. Ho 95-988 has been expanded, but at a slower rate due to top breakage, especially during peak summer growth. In 2006, there are two potential variety releases, L 99-226 and L 99-233. These two varieties also offer excellent sugar yield potential and resistance to brown rust. Breeding efforts continue as the work to diversify Louisiana's sugarcane acreage continues. Louisiana has learned a hard lesson on the risks of monocultures.

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GENOTYPE x REGION INTERACTIONS IN AUSTRALIA AND IMPLICATIONS FOR BREEDING PROGRAMS.

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In Australia there are five major sugarcane growing regions. These regions vary in latitude, climate, crop management, soil type, and presence of important diseases. Separate selection and breeding programs in each region have been maintained. Genotype x environment (GE) interactions have been extensively studied within regions, but no studies on the relative importance of genotype x region interactions had been done previously. Selection decisions were generally made on the assumption that data from a selection trial within any given region better predicted performance for that region than data from different regions.

Between 2000 and 2004, a set of unselected clones representing genotypes generated routinely in Australian sugarcane breeding programs were evaluated in trials (4 row x 10m plots x 2 replicates per trial) across 24 sites and 3 crop-years per site.

We found that genotype x region interactions were relatively small for both sugar content and cane yield, compared with GE interactions within regions and genotype main effects. Consistent with this, genetic correlations between trials from different regions were only slightly smaller, on average, to correlations between trials in the same region. These results indicated that data on CCS and cane yield from a selection trial in any given region is of high relevance to all other regions.

Based on the results, we recommended that (i) selection of clones for the final stages of evaluation in each region should draw on advanced stage selections from other regions to a greater extent than previously, (ii) that data from all regions be combined appropriately in analysis (using correlation parameters estimated) to predict genetic and breeding values of clones for each region, and (iii) that the value of maintaining separate breeding programs be further investigated. The results from this project are therefore being used maximise overall genetic gain made from the combined efforts of the regional programs.

The approaches being taken above may be extended to an international context.

There may be mutual benefits for breeding programs targeting different countries in knowing the relative size of genotype x country interactions (ie. relative to G main effects and GE interactions within countries). This could lead to more targeted use of each other's data, breeding germplasm, and advanced selections, and offer mutual gains to collaborating parties. A proposal is suggested which could initially involve a coordinated exchange among interested breeding programs of seed from elite parents/crosses and standardised evaluation of families.

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ADAPTING A BREEDING PROGRAMME TO MEET NEW INDUSTRY NEEDS: FROM SUGAR TO BIOMASS AS QUICKLY AS POSSIBLE

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The small sugar industries of the Caribbean have traditionally relied on the export of raw sugar, mainly to Europe, for their survival. With the rapid enforcement of a reduced pricing regime, they are forced to adapt their industries to the production of new products so that cane cultivation may be maintained. The individual countries will adopt their own particular mix of products to achieve this. The range of outputs will vary, but include biomass for fuel, electricity from bagasse, fuel ethanol, rum, molasses, sugar for local consumption and special "branded" sugars for export. The breeding programme in Barbados has had to be adapted to all of these needs, and do so quickly. This has lead to a radical change in parental selection and the development of new selection methods. New varieties are required immediately in some cases and in the near future in all cases. This paper will describe how the breeders have attempted to cope with this rapid change. New parental populations have been generated or selected from existing germplasm with the aim of combining biomass production, high Brix, extended ratooning and vigour. In the case of Barbados, varieties that are able to be reaped throughout most of the year, not only in the traditional sugar crop season, must be developed as fuel canes. The challenges experienced in doing this and some of the solutions found will be discussed.

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ASSESSING A PATHOGEN-FREE SMUT SCREEN - NEAR INFRA-RED SPECTROSCOPIC SCANNING OF AXILLARY BUDS

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The eastern Australian sugarcane industry is vulnerable to sugarcane smut (Ustilago scitaminea Syd.), with 79.9% of the 2004 Queensland crop (33.6 x 106 t cane) produced by 39 (of 49) cultivars rated = 6.0. Cultivars, advanced clones, and parents are screened in a collaborative program with the Indonesian Sugar Research Institute. A more rapid screening process would reduce the breeding generation interval. A pathogen-free test would produce results faster, and allow domestic screening.

The objective was to assess near infra-red spectroscopic (NIS) scanning of axillary buds to predict smut resistance. The research was facilitated by the short-term loan of a Fourier-transform spectroscope (Bruker Optik GmbH, Germany; Model Matrix-F, duplex).

The spectroscope was powered for field use by a 12/240 V inverter (Selectronic Australia Pty Ltd, Model LD450-12) via an un-interruptible power supply (Chloride Australia, Model Active 100). A fibre-optic solid probe (Solvias AG, Switzerland, Model IN268, 2 m, 7/7 x 600 µm) was connected to the instrument via a flexible 2-m fibre-optic umbilical. The solid probe, ~ 300 mm long, was mounted in a vertical guide that allowed the 60° angled end to be placed precisely on each axillary bud scanned. The probe's heel was placed against the leaf scar. The instrument's resolution was 16 cm-1. Fifty spectral scans were averaged for each bud. Fifty background scans were taken of a Spectralon standard (Labsphere, Inc., NH) between clones. Bruker Optik's OPUS software was used for instrument operation, spectral data capture, manipulation, and calibration.

Three populations were scanned: 1). 289 clones that had been shipped for testing at least twice; 2). 20 of these that occurred in two locations on BSES Meringa; and 3). Three cultivars, Q96 (smut rating 4.6; n > 8 trials), Q117 (8.2; n > 8 trials), and Q200A (1.5: n = 2 trials). Three most basal 'verdant' axillary buds on each of three stalks were scanned for 1). and 2). All buds on each of five stalks were scanned for 3).

The mean smut rating for the 289 clones was 7.0 ± 1.9. Their smut ratings could not be predicted from NIS data. Analysis of variance of spectral data for the 20 clones from two locations revealed significant differences between samples, but no differences among clones. Analysis of spectral data for Q96, Q117, and Q200A revealed no differences among stalks, over cultivars, but highly significant differences among cultivars. Possible reasons for these disappointing findings are discussed.

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PLANT BREEDERS' RIGHTS FOR SUGARCANE CULTIVARS IN AUSTRALIA -A 10 YEAR HISTORY

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Plant Breeders' Rights (PBR) is the exclusive commercial rights to a registered variety or cultivar. In Australia, the PBR scheme is administered by the Plant Breeders' Rights Act 1994, which conforms to the 1991 revision of the UPOV convention. The UPOV Convention provides options for the methods used to determine Distinctness, Uniformity, and Stability (DUS). The approach used in Australia for determining DUS is the 'breeder-based testing system'. Since 1995, BSES Limited has been protecting the Australian sugarcane industry's investment in breeding new sugarcane cultivars by registering new cultivars for PBR. Currently, 64 sugarcane cultivars are protected by PBR in Australia, including 57 with Grant status and 7 with Provisional Protection. Four cultivars bred by CSR are included in this total. The process begins with the completion of a Part 1 application that establishes a prima facie case that the cultivar exists and is distinct from other cultivars of 'common knowledge'. A Qualified Person (QP) is also nominated in the Part 1 application. A comparative trial is then conducted to compare the new cultivar with the most similar cultivars of common knowledge and parents if possible. The trial is used to measure morphological characters (quantitative and qualitative) for completing the Part 2 application (DUS) via an online Interactive Variety Description System using harmonised descriptors and states of expression from the UPOV technical guidelines. The description is then published in the online Plant Varieties Journal to allow for a 6-month period for objections. Sugarcane growers in Australia who sign the BSES Service Fee agreement are allowed unrestricted access to PBR protected cultivars that are approved under the Plant Protection Act 1989 for their area. However, a royalty on the harvested product can be sought from growers that do not sign the service agreement and are growing PBR cultivars. During the 2004 season, about 46% of the cane sent to Queensland mills was from PBR-protected cultivars and this is expected to rise to over 60% in 2005.

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THE PLANT BREEDING MANAGEMENT INFORMATION SYSTEM, A TOOL TO IMPROVE THE UTILIZATION AND MANAGEMENT OF SUGARCANE GERMPLASM IN THE MSIRI PROGRAMME

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Sugar cane breeding activities generate an impressive amount of data, which should be processed efficiently to ease decision-making and for retrieval of information. Many sugar cane breeding organizations have their own database management systems, which have evolved with the acquisition of modern computing systems with enhanced capabilities. This presentation reviews the progress achieved in the use of information technology in the MSIRI sugar cane breeding programme and the development of the a computerized information management system, the PBMIS, with emphasis on the germplasm and hybridization components.

At the MSIRI, computerisation of breeding records started as early as the mid-1960s when data were recorded on punched cards. In the late 1980s a multi-user computer, IBM 6150, was installed and the operating system was UNIX and computer language was FORTRAN 77 and C+, supplemented by the NAG FORTRAN library for statistical analyses. Data has been preserved in the form of electronic files and ultimately in relational databases. Improved system analysis and programming techniques were employed for retrieving data and managing databases with a combination of C language and SQL. In 1996, with the acquisition of Personal Computers (PC) and Microsoft Windows, the hardware environment changed completely with the installation of PCs linked to a Local Area Network (LAN). A whole range of new software was introduced including SQLBase as a Data Management Software (DBMS) and SQLWindows was used as a development and query tool of relational databases. The main databases were redesigned and regrouped under one single database, the 'Plant Breeding Database' (PBDB). Consequently the 'Plant Breeding Management Information System' was developed with a view to restructure and centralise all available data on a main server and provide access to information for several users simultaneously.

The PBMIS comprises a relational database, the PBDB, and a menu-driven application programme, which provides the necessary facilities for addressing queries or for recording new results. The PBDB database is organised in the form of tables grouped into 3 main components namely germplasm, hybridization and selection. The integration of the hybridization module has implied the conversion of thirty years of past data on crossing, sowing, potting and planting of seedlings into the new redesigned database structure and allows retrospective search and analysis of past hybridization activities. A multi-user application software has also been developed with built-in procedures for effective data querying, processing of directed crosses, stock control of seeds and reporting.

The PBMIS has enabled information to be processed more efficiently and made more readily available to breeders for rapid decision-making in the use and management of germplasm.

Keywords: sugarcane, hybridization, data, relational database, information system, germplasm, Mauritius.

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FLOWERING INDUCTION UNDER TROPICAL CONDITIONS OF ECUADOR

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Sugarcane flowering in Ecuador is poor and variable. The Germplasm collection with 500 varieties and clones has flowered only 25 to 30% under natural conditions during the last five years. This character puts a limit to the breeding program to combine clones and select the best parental combinations. In 2003, the Ecuadorian Sugarcane Research Center (CINCAE) established a facility with three photoperiod chambers, in order to induce flowering and arrange local parental combinations. Flowered induction started with a treatment of 14 hours to prevent flowering and synchronize the flower outcome. The treatment to induce flowering started with 12 hours and 55 minutes of light per day, with a 60 s reduction of light per day in 2003 and a 45 s reduction of light per day in 2004 and 2005. In 2003, the first year of operation, flowering occurred in 87.5% of the varieties with 82.2% of stems with flowers, compared to the group of standards where only 2.1% flowered. In 2004 and 2005 induction treatment resulted in 57% flowering, while varieties not induced showed 20% flowering in 2004 and 0% in 2005. These results demonstrate the effectiveness of flowering treatment under controlled conditions at CINCAE.

Keywords: Flowering, induction, photoperiod.

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POSTER SESSION

FAMILY EFFECTS AND PHENOTYPIC CORRELATIONS AMONG INDUSTRIAL QUALITY ATTRIBUTES OF SUGARCANE

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Conventional and not-conventional attributes affecting sugarcane industrial quality have been recently investigated by the breeding programme developed by INTA at Tucumán, Argentina. The purpose of this research was to understand the nature of associations among ten different quality traits of sugarcane. Phenotypic correlation analyses were first estimated across family traits such as Antocyanins (Ant), Phenols (Phe), Phosphates (P2O5), Starch (Sta), Dextrane (Dex), Theoretical Recovery Sugar (TRS), Reducing Sugars (RD), Fiber (Fib), Ash (Ash) and Potassium (K). Pearson correlation and multivariate Principal Components Analysis (PCA) were carried out with the laboratory analysis performed through 20 hybrid families, from which 11 contrasting combinations (B, E, F, H, I, L, M, P, Q, R, T) were selected to represent diverse quality measurements of the progenies. Associations among attributes were expressed at population and interfamily levels. At the population level positive and significant correlations were detected for K:Ash and Ant:Phe, while strong negative correlations were found for RD:Sta, RD:TRS, TRS:Phe and Dex:P2O5. At the interfamily level negative significant correlations were detected for K:P2O5, RD:TRS, TRS:Phe, Dex:P2O5 and P2O5:Ant, while they resulted positive and significant for Fib:Ash and Dex:RD. Interesting similarities and differences were observed among hybrid families when the 10 quality attributes were analyzed jointly. In fact, families E, F, L, M conform a group showing intermediate measurements for all quality traits. R, Q, H present moderate to high for TRS and P2O5 and low Sta. Other families appeared to be different in their behavior, but could not be grouped through their quality attributes. Family T presents low TRS, but high K and Ash. Family I shows low TRS, Ant and Sta, but is high in RD. Family P is high in K, Dex and RD, but is low in TRS and P2O5. Family B exhibits high levels for P2O5, TRS, but low ones for K, RD and Dex. According to these results family selection could be effective if it is directed to reject combinations that present juice components that could affect negatively fabrication process.

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CRYOPRESERVATION AS A TOOL FOR LONG-TERM CONSERVATION OF SUGARCANE GERMPLASM

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Cryopreservation, i.e. the storage of biological material at ultra-low temperature, usually that of liquid nitrogen (-196oC) is the only technique currently available to ensure the safe and cost-efficient long-term conservation of vegetatively propagated plant species. At this temperature, all cellular divisions and metabolic processes are stopped. The plant material can thus be stored without alteration or modification for a theoretically unlimited period of time. Moreover, cultures are stored in a small volume, protected from contamination, and require a very limited maintenance. Today, cryopreservation protocols have been developed for well over 100 different species and the number of cases where it is routinely used in the genebank context is increasing steadily.

In the case of sugarcane, a cryopreservation protocol has been developed at the beginning of the 90's in the framework of FAO and IPGRI funded collaborative projects between French and Cuban institutes. The protocol uses the encapsulation-dehydration

technique, in which apices are encapsulated in beads of calcium alginate, pre-treated with high sucrose concentrations, submitted to partial physical desiccation before freezing. This protocol has been successfully applied both in France and in Cuba to a total of 15 different commercial varieties, with recovery rates after freezing ranging between 24 and 91 %. Biochemical and agronomic studies have not revealed any difference between plants coming from non-frozen and frozen material.

Based on the results obtained, it is considered that the protocol is ready for large scale application in a genebank context, even though it should be compared with a new protocol named droplet-vitrification, which might be easier to implement and produce higher recovery. The implementation of cryopreservation is envisaged in the Cirad Roujol Station in Guadeloupe, for the long-term storage of plants which are difficult to maintain in the field, of released varieties, of virus-free plants and of plants with particularly interesting characteristics.

Another potential application of cryopreservation is cryotherapy, i.e. the elimination of viruses through apex cryopreservation. In the case of sugarcane, this would be particularly interesting for the elimination of the sugarcane yellow leaf virus (ScYLV). A research programme should be implemented to compare the efficiency of cryotherapy with meristem culture.

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GENETIC DIVERSITY OF SUGARCANE GENOTYPES (Saccharum species hybrids) USING AGRONOMIC ATTRIBUTES AND RAPD MARKERS

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Genetic relatedness of eleven sugarcane genotypes was analysed using agronomic traits and RAPD markers in order to assess the genetic distance among the putative parents to enhance the efficiency of genetic improvement of sugarcane through breeding in sub-tropical India. Twelve agronomic traits were scored in each genotype in plant crop and ratoon. The data was subjected to generate dissimilarity matrix using NTSYSpc. The dissimilarity coefficients ranged from 0.57 to 2.34 with a mean value of 1.36. RAPD using sixteen selected primers with highly polymorphic band profiles produced 128 markers of 200 to 2000 bp with 3 to 13 amplification products/primer. Similarity coefficient for RAPD computed through NTSYSpc ranged from 0.16-0.91 with a mean similarity value of 0.59 suggesting that the sugarcane genotypes share a closely related genetic background. The genetic symmetry/dissymmetry matrices were used to perform cluster analysis using the UPGMA (Unweighted Pair Group Method with Arithmetic Mean clustering) method following the SAHN cluster analysis module of NTSYSpc. The dendrograms obtained with agronomic attributes and RAPD markers agreed in principle, in clustering the genotypes assayed in two main groups and showed cophenetic correlaion values of 0.71 and 0.82 respectively. At X-axis, CoLk 8102, CoJ 96192 and CoPt 84212 clustered together in both the dendrograms. Besides, Co 1148, CoC 671, P.O.J. 2883 and CoS 767, which derive their origin from partially common gene pool of P.O.J. 2364 and S. officinarum E.K. 28, also grouped together. The second cluster at Y-axis contained only two genotypes CoH 110 and BO128 in both the dendrograms. Comparisons of molecular to agronomical data produced generally similar conclusions of relatedness among genotypes within the clusters. High genetic similarity coefficients (0.46 to 0.91; mean value 0.65) through RAPD in cluster I (with nine out of eleven genotypes) indicated narrow genetic background of these genotypes. This necessitates the screening of a higher number of genotypes through RAPD for studying genetic diversity within the sugarcane genotypes to enable the selection of the best parents in order to obtain new genetic combinations.

Keywords: Diversity, morphology, polymorphism, Saccharum, RAPD

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VENEZUELAN SUGARCANE VARIETY DEVELOPMENT PROGRAM

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In Venezuela, commercial sugarcane (Saccharum spp.)varieties originate from two sources, imported from sugarcane producing countries and a breeding and selection program of the "Instituto Nacional de Investigaciones Agrícolas (INIA)", a public institute assigned to the Science and Technology Ministry. Varieties from the Venezuelan sugarcane variety development program (VSVDP) comprised most of the total acreage in which sugarcane is grown. The head office of the VSVDP is located at the Yaritagua Experimental Station near the city of Yaritagua, Yaracuy state. The program is a cooperative effort that includes farmers, Fundacaña (private sector) and INIA. Since 1958, the Venezuelan program has been developing clones with "V" prefixes. The selection cycle from crossing to variety release is approximately 12 years. The VSVDP comprises a five-stage testing, a seedling stage and four consecutive stages of clonal selection. Each year at Yaritagua Experimental Station, about 15.000 seedlings are planted in the field. Seedlings are selected at an intensity of 8 to 10% and advanced to the next stage. Stages II and III consist of tests grown in unreplicated plots. The seedling stage and stage II are evaluated for one year. Stages III and IV clones are evaluated in the plant cane and first-ratoon crops. Stage V clones undergo three years of evaluation at several locations (outfield trials). Stages IV and V are tests grown in replicated plots. Approximately 1.500, 200, 30, and 5 clones are advanced to stages II, III, IV, and V, respectively. Clones that successfully complete all the experimental stages are released to the farmers as promising varieties.

Keywords: Saccharum spp., selection, breeding, seedlings, clonal selection.

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RELEASING THREE PROMISING SUGARCANE VARIETIES IN VENEZUELA

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Three new promising varieties of sugarcane (V84-8, V84-15 and B82-11) were released during the year 2005 by the Venezuelan Sugarcane Variety Development Program (VSVDP). These clones were chosen based on their performance throughout different stages of selection in infield trials and in outfield trials carried out in most of the areas in which sugarcane is grown (Aragua, Carabobo, Yaracuy, Lara, and Portuguesa states). Research indicates that V84-8, V84-15 and B82-11 have yields of sugar and cane per hectare comparable to commercial check varieties used in different site trials. V84-8 is a clon derived from the Venezuelan breeding program. It is a high yielding variety with an average yield of 114.6 tons of cane per hectare and 14.9 % Pol, outperforming the check varieties at most of the yield trial sites. V84-8 showed a good ratooning, early flowering, and it is moderately resistant to most diseases currently found in Venezuela (rust, smut and mosaic). V84-15 is another variety derived from the Venezuela breeding program. V84-15 is a good yielding variety with an average yield of 101.9 tons of cane per hectare and 15.4% Pol. V84-15 flowers scarcely, it is moderately susceptible to leaf scald and susceptible to rust and smut. B82-11 is a variety derived from the breeding program at West Indies Central Sugarcane Breeding Program in Barbados and selected by the Venezuelan breeding program. With an average yield of 105.9 tons of cane per hectare and 15.0 % Pol, B82-11 outyielded the check varieties at most of the yield trial sites. B82-11 is a good ratooning variety, early flowering, and is susceptible to smut and mosaic. All three varieties have a semi-upright appearance and are susceptible to stem-borers. The fiber content was within the limits of 13-14 % for the three clones. All three varieties were released as promising varieties with the hope that at least one variety will perform well and become a commercial variety.

Keywords: Sugarcane, breeding, selection, clones.

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GENETIC DIVERSITY ASSESMENT OF THE ECUADORIAN SUGARCANE COLLECTION USING RAPD MARKERS

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The genetic variability conserved in Germoplasm collections is important for any improvement program. For better use of this germoplasm, molecular and morphological characterization should be arranged for. A molecular characterization of 249 varieties corresponding to the second half of the germoplasm bank of CINCAE was carried out using AP-RAPDs technique. The technique combines the use of arbitrary primers with the enzymatic synthesis of multiplex copies of DNA. Twenty nine decamer primers from OPERON Technologies generated a total of 154 polymorphic bands ranging from 500-3900 bp. The number of amplified products yielded an average of 5.31 fragments per primer, and the number of polymorphic DNA fragments generated ranged from 3 to 10. Polymorphism percentage calculated from total bands amplified with the polymorphic bands was 37.29%.

Genetic Similarity coefficients were obtained using the NTSYS-pc program, option Jaccard, and the UPGMA clustering algorithm generated a dendogram. There were 82 (33.3%) varieties/clones did not group clearly, but the majority of them formed 20 distinctive clusters. Average Genetic Similarity amongst genotypes was 65.5%. The most planted variety in Ecuador, Ragnar, was located in group 14 with 0.59 similarity coefficient together with CP33-224 and CP52-43 which are known to be high sucrose content.

Keywords: Sugarcane, AP-RAPDs, polymorphism, Jaccard coefficient, UPGMA, clusters.

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CENGICAÑA SUGARCANE VARIETY DEVELOPMENT PROGRAM

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Sugarcane breeding and improvement task in Guatemala began in 1992 as part of the Guatemalan Sugarcane Research and Training Center (CENGICAÑA, by its acronyms in Spanish). Currently the Guatemalan sugarcane industry has a complete dependance on foreign varieties. A huge risk for the development of an epidemic exists since CP72-2086 variety has been leading the growing area reaching in the 2002-03 harvest season up to 75 percent of the 185,000 ha sugarcane growing area. This particular situation in line with the need for varieties well adapted into the heterogenous area to enhance this weak varietal composition and a need to increase sugar yield were the factors that made the Guatemalan sugarcane industry to establish the Sugarcane Variety Development Program. The objective of this work is to describe the general strategy of the Variety Program as well as to present the first promising CG (CENGICAÑA Guatemala) varieties being grown commercially during 2005-06 harvest season.

The strategy is based on four major components: germplasm source, crossing program, selection program and release of new sugarcane varieties, being the breeding objectives high sucrose content, high cane yield, disease resistance, adequate agronomical characteristics and adapted to local growing conditions. The Variety Program has a Sugarcane National Collection, integrated by 1,299 accessions mostly complex Saccharum hybrids from different places of the world. This collection has been agronomic and phytosanitary characterized and molecular characterization is still beginning. The crosses are carried out in a crossing house and perform 160 crosses, producing 80,000 seedlings per year. The Selection Program consists of five selection stages, beginning with seedlings evaluation and end up in stage V with semicommercial evaluations. In Guatemala during harvest season 2005-2006, 1,200 ha of sugarcane crop were cultivated commercially with the first promising CG varieties which are CG96-01, CG97-97, CG96-40, CG96-59, CG97-100 and CG96-52. These varieties were produced from the second and third crossing campaigns made at CENGICAÑA crossing facilities and they are characterized by their good yield components and appropriate reaction to diseases. Results from these commercial areas allow us to conclude 1) The general strategy for developing improved and adapted Sugarcane Varieties into the Guatemalan agroclimatic conditions is being establishid with promising results and 2) First promising CG varieties still under assay in Stage V of selection are under commercial evaluation with promising results during harvest season 2005-06.