

Sugarcane Breeding in Thailand

Preecha Suriyapan¹

Abstract

Sugar cane breeding work in Thailand is carried out in the frame work of a national program. Several research centres and agricultural colleges and the Sugar Insititute collaborate in a new selection and zonal evaluation scheme. The application of modern biological and mathematical techniques is expected to improve the efficiency of this program.

Key words : Sugar cane, breeding, flowering control, germplasm collection

Introduction

Sugar cane breeding began in Thailand after the Thai government set up the first sugar mill in Lampang province in 1938. Following the expansion of the area under production. At that time, native sugar cane varieties such as Oi Daeng and Oi Kha kai were grown to supply the mills. Foreign varieties were later introduced for the breeding programmes of the Lampang and Uttaradit mills. Two useful varieties released by the Lampang Sugar Mill were Lampang 5 and Lampang 9. With changes in government policy, the sugar cane breeders from the Lampang Sugar Mill were transfered to the Sugar Institute(SI) which was established in 1968. However, the breeding programme declined subsequent to that change. A new programme of breeding and cultivation research was initiated by the Bang Phra Pilot Mill in Chon Buri province a few years later; the programme produced three promising varieties, Bang Phra 6, Bang Phra 11, and Bang Phra 45.

In 1974 the Department of Agriculture (DOA) initiated a sugar cane breeding programme with collaboration between the SI, agricultural colleges and field crops experiment stations. In 1979, a crossing and selection scheme began which has shown gradual but consistent improvement (Suriyapan *et al.*, 1979). By 1989, the new varieties, U thong 1, and Chai Nat 1, had been recommended and adopted by Thai sugar cane growers.

Climatic Characteristics of Sugar Cane Growing Area

Thailand is located between latitudes of 5° N and 20° N and longitudes of 98° E and 103° E and is characterised by a tropical monsoon climate. The rainy season extends from April to October. Annual average precipitation recorded in the Western Region where most sugar cane is grown ranges from 1089 to 1524 mm. The maximum temperature ranges 33 – 38° C over most of the year. however low temperatures can occur in December and January. The maximum

¹ Field Crops Research Institute, Department of Agriculture, Chatuchak, Bangkok, 10900

temperature is 39° C and the minimum is 13° C. Mean relative humidity ranges from 40% to 85%

Germplasm Collection

A collection of 359 accessions is maintained at the Suphan Buri Field Crops Research Centre. This collection consists of accessions of *Saccharum officinarum* (2) and *S. spontaneum* (2) and 355 hybrids of diverse genetic and geographical origin. A major source of material is from Copersucar in Brasil. Hundreds of additional accessions have been recently introduced to Thailand and are being screened through quarantine procedures. Any outstanding lines obtained at our fourth selection stage are also included in the collection, as also any others which exhibit potentially interesting characteristics during the selection process.

The evaluation of the collection is carried out under different soil and climatic conditions. Agronomic, industrial, botanical, and any other features that affect general plant health, vigour and commercial potential are evaluated. Their behaviour under adverse growing conditions, such as drought and soil salinity are also recorded.

Control of Flowering

Flowering has been an obstacle to sugar cane breeding work for many years. In the past hybridization of sugar cane was carried out at the Rayong Field Crops Research Centre in Eastern Thailand, where most sugar cane varieties flower profusely. More recently, induction of flowering by photoperiod treatment has been successful at the Suphan Buri Field Crops Research Centre. Each year an average of 30 non-flowering parent varieties are treated. February planted cane is

transplanted into plastic bags when it is about one meter high (about the end of May), and placed on carts. The plants are watered daily and fertilized with a minimum amount of nitrogen. The optimum treatment for inducing flowering has proven to be the exposure of cane plants to a constant day length of 12.5 hour starting on 1 July. About half of the treated varieties have produced flowers under these conditions, and have then been used in crossing programmes.

Crossing Technique

Field crossing utilizes the Hawaiian solution (sulphurous acid 0.30% and phosphoric acid 0.01%) for preserving the male parent while the female is kept *in situ*. Marcoting is sometimes used, especially for poly crosses.

Hybridization is performed at the Suphan Buri and Rayong Field Crops Research Centres, from the end of October to January, the peak period being between November and December. Crosses are carried out at hybridization plots flowering collection blocks located in specific regions. The microclimate of the Rayong field Crops Research Centre in Eastern Thailand favours flowering even in shy varieties.

Selection Scheme

Based on the experience in Thailand and other sugar producing countries during the past ten years, a new selection scheme has been adopted for Thailand (Suriyapan *et al.*, 1979). The scheme is divided into four steps: seedling plots (stage I), clonal plots (stage II), preliminary zonal evaluation (stage III), and farm trials (stage IV). Components of each stage are Summarized in Table 1.

The selection process lasts between 9 and 10 years. It can sometimes be reduced to 7 years for material classified as elite as a result of their outstanding performance during the first and second stages. The scheme takes into consideration those varieties introduced from abroad for commercial purposes and also subclones obtained by tissue culture which follow a six year selection process.

Stage I : Seedling Plots

During this stage, seedling are individually evaluated utilizing planting distances of 130×50 cm. Individual seedlings are selected with the cane plant and first ratoon being used to establish clonal plots for stage II.

Table 1. Selection Scheme Adopted in Thailand.

Stage	Plot area and design	Harvest	Location
I. Seedlings	Single plants	Plant cane & ratoon	5 locations
II. Clonal plots	2 m rows	— do —	5 locations
III. Preliminary zonal evaluation	Four 8 m rows with 2 replications (random block design)	— do —	5 locations (experiment stations or centres)
IV. Farm trials		— do —	Farmer fields

Stage II : Clonal plots

First stage selected individuals from the first ratoon are planted in a 5 m long rows and evaluated at 11–12 months of age. A tester or check variety is planted after every 5 clones, as the reference control.

Elite individuals selected as plant cane would immediately enter a multiplication phase although their outstanding characteristics would need to be confirmed

in the ratoon cane. Elite genotypes are taken directly into farm trials. The remaining clones are evaluated as plant and ratoon cane.

Stage III : Preliminary Zonal Evaluation

About 200 individual lines selected from the clonal plots are planted each year in a randomised complete block design with 2 replications at 5 Experiment Stations or Research Centres throughout the country. The experimental plots consist of four 8 m rows, an area of 41.6 sq.m. Criteria for selection are shown below.

Sugar analysis is carried out during the harvest season; plot production is weighed for estimates of cane yield and pool yield per unit area are determined.

Stage IV : Farm Trial

Clones selected during Stage III are planted in at least 25 experimental blocks in farmers field, representative of different soil and climatic conditions of the country. Outstanding, well adapted varieties are selected based on their performance as plant and ratoon cane.

Optimum agronomic management of the potential new varieties is also studied during this stage. Fertilization and irrigation responses and also tolerance to doses of commercial herbicides, are all determined in the different soil–climatic zones where the varieties is expected to be grown.

Later, these selections are further evaluated in large scale farm trials before release as new commercial sugar cane varieties. The later evaluation is made using both researcher and farmers criteria.

Selection Criteria: These are criteria for clonal selection :

1. Germination (germinated buds at 30 days and

missing stools at 60 days

2. Canopy stalk length and diameter: stalk diameter not less than 25 mm, and stalk length is depend on growth of cane.

3. Flowering not more than 10% of plant population at harvest in the 2 central rows (number of millable, non – millable and dry stalks).

4. Bud quality more than 5 as International Society of Sugar cane Technology Standand (ISSCT)

5. Stalk inner quality more than 7 (ISSCT standard).

6. Ratooning not less than 95%

7. Sugar content, CCS (commercial cane sugar) not less than 12.

8. Harvest ability, suitable to hand cut.

9. Fiber not less than 13%

10. Disease and pest damage evaluates by entomologists and plant pathologists

Tissue Culture

Tissue culture has began to be used as an important auxiliary tool in sugar cane breeding. Advances have been achieved particularly in relation to obtaining stress resistant sub – clones and in the suppression of undersirable characteristics such as susceptibility to sugar cane mosaic virus, smut etc.

In vitro preservation of germplasm and micro-propagation of high yielding genotypes have been successfully accomplished and are widely utilized cell suspension culture and protoplast hybridization are now being examined in order to overcome incompatibility barriers present in interspecific and intergeneric crosses of *Saccharum* and related genera.

Diseases and Pest Resistance

Obtaining sugar cane varieties resistant to diseases and pests is the first priority.

Any prospective commercial variety must fulfil the following requirements regarding diseases and pest resistance. It must be:

– resistant to smut (*Ustilago scitaminea* Syd), to at least a similar level as the standard varieties, namely, U thong 1, F 140 and Q 83.

– resistant to SCMV.

– tolerant to stem and top borers: *Chilo infuscatellus* Snellen and *Scirpophaga excerptalis* Walker. Several clones combining low borer infestation with high sucrose content have already been identified.

In addition, studies for improving SCMV resistance screening methods are in progress. A group of highly smut resistance parental varieties has been selected and crossed and its progeny is under study

Current Research

A yearly average of approximately 40,000 seeds were produced during the past fifteen years. In each year, five varietal yield trial plots in the main sugar cane growing areas have evaluated collected and newly introduced sugar cane varieties from abroad. Non – lodging varieties were given special consideration in the selection of clones since most farmers in Thailand are still using machetes as tool to harvest sugar cane. However, some strong and hard rind varieties such as F140 are rejected even though they do not lodge and contain high sugar content.

Promising clones were tested against U thong 1, F 140, Q 83 and farmers original variety. Yield and CCS were collected. In 1983, the first commercial cane was released and was named Thai 1 or Chai Nat 1. In 1985, the U thong 1 was released. This variety is more popular and well accepted by the farmers.

Some sugar cane setts were irradiated, but most new irradiated cane flowered less. In 1984, an experiment

was set up with cooperation from the office of Atomic Energy for Peace, in which 50 single bud setts were irradiated with 0, 0.5, 1.0, 2.0, 4.0 kilorads of gamma ray. All treated cane were planted at Rayong Field Crops Research Centre During flowering in December 1984, the treated canes were checked, Only completely non flowering stools were selected from each treatment and cut pieces were grown as M_1V_2 in February, 1985. The selected completely non flowering stools were successively cut and grown until 1987. Unfortunately all irradiated setts flowered in December, 1987 (Suriyapan and Tiraporn, 1988).

In mutation breeding in sugar cane for resistance to smut disease in 1982, selfed seed of Co 775 and N 52-219 were irradiated. At Suphan Buri Field Crops Research Centre seedlings about 3 months old were transplanted to the field. Canes were selected at 8 month old. Six out of 2516 clones were selected. The selected clones were grown in successive years and were tested with *Ustilago scitaminea* spore suspension of 5×10^8 spores/ml. Scoring of disease resistance was according to the ISSCT system. Two clones were selected, they were 7-2-075, and 7-2-077 but unfortunately, they did not pass the commercial standard (Suriyapan and Chatikavanij, 1985).

With *in vitro* culture as a tool for somaclonal variation in sugar cane Suphan Buri Field Crops Research centre. Corolla bud tissue of Pindar, Q 83, F 140, and Thai 1 varieties were reared in Ms plus 5 ppm NAA solid media. All varieties developed well on this media, plantlets were transplanted and survived in the field. Q 83, Thai 1, and Pindar developed a chromosomal mosaic, with more than 0.5 per cent purple and white stripe appeared. Soms clones were then selected and included in the regular variety programme (Charoenchitr and Suriyapan, 1985)

References

- Charoenchitr. S. and P. Suriyapan. 1985. Mutation breeding in sugar cane for high sucrose, pest and lodging resistance, *in vitro* culture as a tool for somaclonal variation. In Suphan Buri FCRC Annual Report 1985. (in Thai)
- Suriyapan, P., M. Somabhi, and P. Chatikavanij. 1979. Sugar cane breeding programme in Thailand. Thai J. Agr. Sci. 12:71-75.
- Suriyapan, P. and P. Chatikavanij. 1985. Mutation breeding in sugar cane resistance to smut disease. Memio.
- Suriyapan, P. and C. Tiraporn. 1988. Mutation breeding in sugar cane for suppression of flowering. Memio.