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# PAKISTAN SUGAR JOURNAL

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# EDITORIAL
# RECORD GLOBAL PRODUCTION KEEPS CONSUMPTION NEAR RECORD HIGH

**United States**' production is forecast up slightly to 7.9 million tons. Imports are expected to jump 662,000 tons to a record 3.5 million based on projected quota programs and the calculation of U. S. Needs, as defined in the anti-dumping and countervailing duties suspension agreements effective December 2014. Consumption and stocks are both forecast up slightly.

**Brazil's** production is forecast to rise 500,000 tons to a record 39.7 million on favorable weather and a 1-percent increase in sugarcane being diverted towards sugar production instead of ethanol. Exports are projected up 500,000 tons to a record 28.7 million on greater exportable supplies. Stocks are forecast up slightly while consumption is relatively unchanged.

**Guatemala's** production is forecast up 100,000 tons to a record 2.9 million on higher sugar recovery rates. Over the past 30 years, production increased at twice the pace of area expansion due to either increased cane yields in the field and/or higher recovery rates at the mill. With little land left for sugarcane expansion, higher production is mostly driven by improved sugar recovery rates. Exports are forecast flat at 2.1 million tons.

**India's** production is forecast to rebound by 18 percent to 25.8 million tons due to higher area and yields. Imports are forecast lower while consumption is forecast to edge higher to 26.0 million tons.

**Pakistan's** production is reported highest in the history to a record production of refined sugar of 7.1 million tons. Domestic consumption is forecasted around 4.1 million tons. Pakistan is now having potential to export refined sugar of about 3.0 million tons during production season of 2016-17. Exports drop due to lower price of sugar in international market.

**Russia's** production is forecast to slide 350,000 tons to 5.8 million on lower yields compared to the unusually high yields the year before. Consumption and stocks are both forecast to decline as a result of lower production.

**Thailand's** production is forecast to expand 1.2 million tons to 11.2 million as yields are expected to improve with the recovery from 2 years of drought. Exports are forecast to rise 400,000 tons to 8.4 million on increased available supplies while consumption is up slightly on growing household and industrial uses.

The Thai government is planning to deregulate the domestic sugar market in response to a petition filed by Brazil to the World Trade Organization. On October 11, 2016, the Cabinet approved a restructuring plan for the cane and sugar industry where the government will amend the current Cane and Sugar Act B.E. 2527 (1984), eliminating the sugarcane price support program, the domestic sugar price controls, and the sugar sale administration. If implemented, from MY 2017/18 onward, the government will no longer provide domestic price subsidies and direct payments to cane growers. Additionally, the current price controls on refined sugar will also be eliminated.

# FROM BIOETHANOL WASTE TO A PROTEIN-RICH FEEDSTOCK - A NEW TECHNOLOGY

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## ABSTRACT

Microbial biomass protein from Candida utilis yeast was produced using distillery vinasse as the sole source of carbon and energy. The process was carried out from lab scale to 200 m3 fermentors. Propagation media have to be supplemented with nutrients since vinasse cannot provide all compounds needed for a stable operation. Different mixtures of molasses-enriched vinasse were tested and finally a microbial growth enhancer (MGE) was incorporated to the media to ensure its optimisation. MGE-supplemented vinasse at 0.03 kg/m3 was found optimum for yeast propagation. At industrial scale μmax ≥ 0.33/h was obtained which allowed a stable behaviour of the culture at this scale and a significant industrial productivity. Yeast biomass from vinasse showed a composition and amino acid profile very similar to those previously obtained from molasses medium. A nutritional test demonstrated that vinasse´s yeast is an excellent source of proteins for animal feeding and an efficient pollution reducer.

## INTRODUCTION

The Cuban Institute for Research on Sugarcane By-Products (ICIDCA) has vast experience of more than 40 years in the field of yeast technology. This journey set off with the early lab research works about the development of Candida utilis (fodder yeast) from sugarcane molasses. The results were implemented at industrial scale in 1963 when a 30t/d factory started. Later, from 1979 to 1982, ten new plants were installed and operated at full scale. ICIDCA's technicians, researchers and engineers took part in those ventures defining the technology, doing equipment selection, strain evaluation, assembling and training of operating personnel among other tasks. Sugarcane agro-industry is one of the most contaminating sources of underground waters (Pawar *et al*., 1998).

However, on the other hand, it has been one of the most job-generating industries in the Latin-American region and sugarcane is one of the plants with the highest utilisation efficiency of solar energy and its conversion into biomass. In ethanol production, wastewaters consist of cooling waters from condenser and fermentation vats, as well as liquid wastes from distillation. Among the wastewaters generated by sugar-ethanol industrial complexes, vinasses stand out as highly polluting agents due to their content of organic compounds, whether biodegradable or not. Vinasses are produced at a rate of 10 to 16 cubic metres per cubic metre of distilled ethanol. Chemical oxygen Demand (COD) of vinasses varies according to the fermentation and distillation efficiencies but roughly ranges from 30 to 65 kg/m3 (Otero *et al*., 2002). The first lab approaches to the utilisation of vinasses for the propagation of microbial biomass can be tracked back to the late 60s (Almazán, 1968). The reduction of organic load and, at the same time, the production of valuable and scarce protein is the best feature of this process (Otero *et al*., 2007). Yeast propagation from vinasses can be carried out in continuous culture at lab scale for long periods of time (Almazán, 1968). However, when scaled up to industrial level, vinasses need the nutritional supplementation of the culture broth because otherwise the system stability would be extremely uncertain due to the poverty of this waste in essential nutrients.

In addition, the typical fluctuations in industry would be an evident drawback. However, those inconveniences can be overcome by supplementing them with industrial syrups from the sugarcane industry, e.g., blackstrap molasses, B molasses, etc. or by growth promoters available in the international market (Martínez *et al*., 2004; Otero *et al*., 2010). In respect to the technological feasibility of this process, three factories -based on this technology have operated in Cuba since 1999, with a production of more than 50 thousand tons up to now (Otero *et al*., 2002; Saura *et al*., 2002; Otero *et al*., 2007). The present paper is an overview of the whole process development that made that achievement possible.

## MATERIALS AND METHODS

### Microorganisms

Different yeasts from the species Candida utilis were evaluated about their affinity to the carbon source. Among them, we used Candida utilis 129 from the ICIDCA collection and several strains obtained from Pasteur Institute in France (C. utilis NRRL Y-660, NRRL Y-900, NRRL Y-1084 and NRRL Y-1082). Inoculums were prepared from agar-malt slants, grown overnight in a medium containing sugarcane molasses at 20 mg/mL of total reducing sugars concentration and nutrient salts (diammonium phosphate and sulfate) to cover cell nutritional requirements and grown in a rotary shaker at 32 $^{o}$C and pH 4.5. A 2.5 l Marubishi MD5 fermenter was used to start batch propagation with a medium composed by molasses-based slops from a local distillery at a COD concentration of 60 mg/mL supplemented with the above mentioned salts in such a way that in all cases COD was the limiting factor of the substrate.

### Chemical analysis

Nitrogen was determined according to Kjeldahl using a Kjeltec Auto System from Tecator AB, Sweden (Anon, 1983). Reducing sugars were estimated by copper reduction according to ICUMSA (2007). Dry matter was done by desiccation at 105 $^{o}$C overnight until constant weight in a vacuum oven at 60 $^{o}$C. Ashes were determined by incineration at 600 $^{o}$C for 4 hours and referred to dry matter content.

## RESULTS AND DISCUSSION

### Evaluation of yeast strains

Candida utilis strains were evaluated in a medium containing vinasse as the sole source ofcarbon and energy. All strains are capable of duplicating at a growth rate close to 0.300/h, with slight differences. It has been previously demonstrated (Martinez *et al*., 2004) that they can metabolise ethanol and glycerol present in the vinasse at a very similar rate. Those values were quite similar to ones reported here. Table 1 shows the values obtained for several kinetic parameters. The constant Ks shows, in all cases, relatively high values. It means, that although yeasts can thrive on vinasse medium (Table 2), this environment is far from optimal, since Ks represents the affinity of cells for the growing medium. Even when the culture was supplemented with molasses, growth parameters did not significantly improve.

Vinasse-molasses mixtures lead to μmax values for C. utilis from 0.338/h for 85:15 mixtures to 0.359/h at 70:30). Both growth rate and yields increased as the molasses amount increased. However, from an environmental point of view, lower amounts of molasses are preferred. Lower COD values in the propagation medium improved the overall organic load reduction. The nutrient contribution of molasses can be substituted by the addition of microbial growth promoters (MGP). The use of MGP QZ-350 (Quimizuk, Havana), from the local market, as molasses substitute, was studied first at lab scale and then taken up to full industrial operation. In both scales, an excellent stability was achieved in continuous culture. Results obtained with MGP are quite similar to those achieved with molasses, so it can be used as molasses substitute for all practical applications. Some properties and composition of

MGP QZ-350 are given in Table 3. The product has higher concentrations of essential nutrients for microbial growth as nitrogen and phosphorus. Thus, it can enhance yeast metabolism even in a relatively poor medium. From these results the three operating vinasse–yeast factories adopted the technology, using MGP QZ-350 instead of molasses. Figure 1 (Martínez *et al.,* 2004) shows the behaviour of C. utilis in a medium composed of vinasse as the sole source of carbon and energy.

Yeast propagation was tested at industrial scale in 200 m3 Vogelbusch fermenters. The culture was scaled from lab to full volume following the traditional steps in the factory. All of them were tested for contamination with wild yeasts or bacteria, cell morphology, cell concentration and protein content. The behaviour of the cell population in all steps was identical to that obtained for molasses yeast in similar conditions. Figure 2 shows the kinetic pattern of yeast cells from lab to full scale (Otero *et al*., 2002). The whole culture at industrial level was stable for more than 90 hours. In fact, same culture was maintained in the fermenters for the subsequent 4 months with no significant contamination, no cell degradation and a protein content about 45%.

## CONCLUSIONS

As shown in this paper, a feasible industrially applied technology, that converts a highly polluting bioethanol waste from a headache into an economically attractive product of high demand, was demonstrated at industrial commercial level. Nitrogen and Kjeldahl protein contents were 6.72% and above 42% respectively. This result gives the possibility to engineer a productive scheme of a bio-refinery that, for the first time, ensures an eco-friendly production of energy and food in a highly effective way.

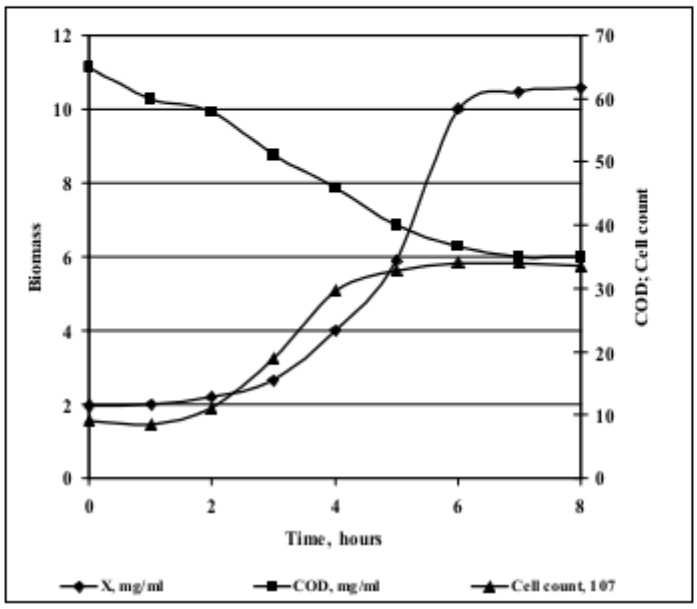


Fig. 1—Multiplication and growth curves of *Candida utilis* NRRL Y-660 in batch culture on vinasse as unique source of carbon and energy.

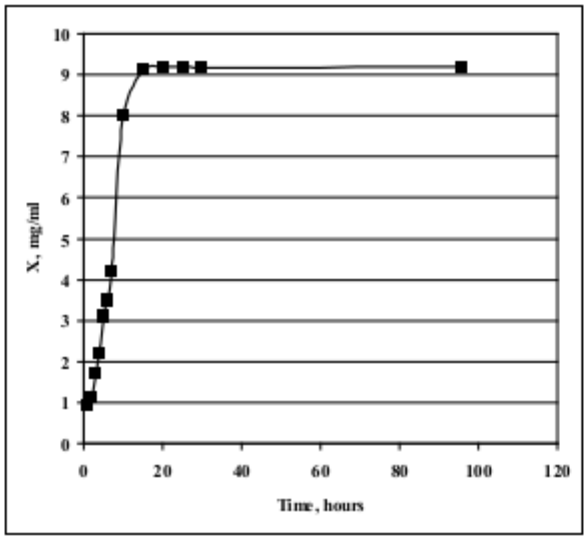


Fig. 2—Behavior of yeast population during continuous culture at industrial scale. Operation conditions: temperature 35°C, pH 3.8, D (=μ) = 0.33/h.

**Table-1 Kinetic parameters of Candida utilis grown on vinasse as the sole source of carbon and energy. Media were supplemented with molasses (70:30 on COD basis)**

| Kinetic parameters | Strain 129 | NRRL Y-660 | NRRL Y-900 | NRRL Y-1082 | NRRL Y-1084 |
|---|---|---|---|---|---|
| Specific growth rate (μmax), $h^{-1}$ | 0.328 | 0.341 | 0.335 | 0.330 | 0.300 |
| Affinity constant (Ks), mg/mL | 0.355 | 0.336 | 0.337 | 0.458 | 0.462 |
| Yield (Yx/s) | 0.286 | 0.312 | 0.259 | 0.280 | 0.234 |
| Maintenance constant (m), mg/mL | 0.109 | 0.102 | 0.119 | 0.123 | 0.126 |

**Table-2 Effect of nutrient supplement on vinasse-yeast Candida utilis behaviour**

| Vinasse-molasses* | μmax, $h^{-1}$ | Yx/s | COD reduction, % |
|---|---|---|---|
| 70:30 | 0.359 | 0.382 | 38.91 |
| 80:20 | 0.341 | 0.323 | 39.97 |
| 85:15 | 0.338 | 0.325 | 41.90 |
| QZ-350, 0.03 mg/mL | 0.304 | 0.307 | 65.32 |
| QZ-350, 0.05 mg/mL | 0.303 | 0.315 | 64.28 |

* expressed as COD

**Table-3 Composition and physical properties of Microbial Growth Promoter QZ-350 (Garcia *et al*., 2003)**

| Properties | |
|---|---|
| Appearance | Yellow powder |
| Ionic character | Cationic |
| pH (water soln 1%) | 4.5–6.0 |
| Moisture | 5.0%, max |
| Kjeldahl nitrogen | 23%, min |
| Phosphorus | 9.2%, min |
| Heavy metals | < 10 mg/kg |
| As | < 1 mg/kg |

## REFERENCES

Almazán, O. A. 1968. Utilización de los mostos residuales para la producción de levadura de forraje (torula) ICIDCA Sobre los deriv, 2 (2): 17–26

Anon 1983. Nitrogen determination by Kjeltec Auto System, Application Note 53, Tecator AB.

García, R., A. Martínez, I. Valdés, *et al*. 2003. Identificación y caracterización cinética de un microorganismo contaminante en la fábrica de levadura forrajera de la empresa azucarera Antonio Guiteras Sobre los deriv, 37 (2–3): 45–50

ICUMSA Method GS 4/3–3 2007. Reducing Sugars in Cane Molasses and Refined Syrups by the Lane+Eynon Procedure.

Martínez, J. A., O. A. Almazán, G. Saura and M. A. Otero, 2004. Production of fodder yeast from stillage: an environmental approach Zuckerindustrie, 129 (2): 92–95.

Otero, M. A., G. Saura, I. Valdés, M. A. Peña, J. Martínez and A. Pascual, 2002. Análisis operacional del complejo destilería-planta de levadura en el CAI Antonio Guiteras. Parte II. ICIDCA Sobre los deriv 36 (2): 7–10.

Otero, M. A., G. Saura, J. A. Martínez, and O. A. Almazán, 2007. Fodder yeast production: a new approach for distillery vinasse treatment Proc. Int. Soc. Sugar Cane Technol., 26: (1127–1133).

Otero, M. A., J. A. Martinez and G. Saura, 2010. Propagación de Candida utilis a partir de vinazas de destilación de etanol y sus componentes individuales Sobre los deriv, 44 (3): 27–32.

Pawar, N. J., G. M. Pondhe, and S. F. Patil, 1998. Groundwater pollution due to sugar-mill effluent, at Sonai, Maharashtra, India Environmental Geology, 34 (2–3): 151–158.

Saura, G., I. F. Valdés, J. A. Martínez, E. Reyes, A. Pascual, and M. A. Otero, 2002. Tecnología de producción de levadura utilizando vinazas de destilería como fuente mayoritaria de carbono y energía Sobre los deriv, 36 (1):20–23.

# TEMPERATURE AND RELATIVE HUMIDITY EFFECTS ON SUGARCANE FLOWERING UNDER NATURAL CONDITIONS IN EGYPT

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**ABSTRACT**

This study consisted of two experiments that were carried out at El-Sabahia Research Station, Sugar Crops Research Institute, (ARC), Egypt, during 2013/2014/2015 (plant cane) and 2015/2016 (ratoon crop) seasons to investigate behavior of selected germplasm (40 genotypes from different origins) under natural flowering and make synchronization for crossing. Results of Individual and combined analysis of variance over two seasons, plant cane and first ratoon revealed significant differences among genotypes for duration of Pre flag leaf stage, duration of flag leaf stage, duration of emergence stage and percent of total flowered plants. The genotypes × inductive cycles interaction was significant for all studied characters. The forty sugar cane genotypes under study were classified into four groups. The first group included fourteen genotypes that flowered in plant cane and first ratoon seasons, and these genotypes ; EI 8-129, M35-157, PS 80-1424, K 81113, L 61-49, AN 56-79, SP 79-2233, G 2009-11, G 2009-10, G 2009-22, G 2009-86, G 2004-27, G 2008-64 and 88/5-27 .The second group consisted of ten genotypes that flowered only under plant cane. These ten genotypes are Koeng Java, SP 72-5181, G 84-68, G 84-47, G 74-96, G 2008-59, G 2006-3, G 2007-61, GT 54-9 and G 2008-20.The third group included two genotypes that flowered only under first ratoon and they are EI 242-16 and G 2006-36 . The fourth group included fourteen genotypes that did not show any response neither plant cane nor first ratoon, these genotypes are CO 775, G2003-47, US 59-161, ROC 10, EI 58-28, EI 8-10, F 161, L 62-96, G 2000-5, G 99-80, SP 80-3250, SP 80-1842, G 2003-49 and Mex 2001-80. Therefore, the forty evaluated sugarcane genotypes varied considerably among themselves in their response to flowering under plant cane and first ratoon. Flowering for genotypes in plant cane was higher than first ratoon because percentage of daily humidity for plant cane (2014) were higher than first ratoon (2015) during flowering stages and the number of days for flowering under the optimum temperature (18-31 °C) during three month (induction and initiation stage) in plant cane was 63 days higher than first ratoon (33 days), all those factors was reasons of flowering in plant cant was higher than first ratoon, so a better understanding of temperature and relative humidity effects on sugarcane flowering is important to study behavior of genotypes flowering and make synchronization for crossing in future between these genotypes.

**Key words:** *Saccharum* spp, sugarcane, genotypes, plant cane, first ratoon, synchronization, flowering

## INTRODUCTION

The development of new varieties of sugarcane from controlled crosses has been greatly extended and established a successful long term breeding program to induce improved varieties. Lack of flowering until 1970´S made it completely impossible to have any breeding program. Flowering by manipulation of nutritional and tissue moisture status of the plant was a success. Beside natural flowering panicle growth, also, is sensitive to temperature so that panicle emergence is delayed at temperatures below 21◦C (Clements & Awada 1965; Nuss & Brett 1977). Coleman (1968), he

reported day's minimum ≤ 18.3 °C and maximum ≥ 32 °C is important for the initiation period. Nuss (1980) reported the best night temperature for flowering to be around 23°C. Restrepo and Ranjel (1984) reported that low night temperatures were the only cause of failure to sugarcane flowering. Moisture is more effect on sugarcane flowering (Clement & Awada, 1964, Pereira *et al*, 1983). The enough moisture is very important and critical for induction flowering, flowering initiation, flower emergence (Moore and Nuss, 1987). Low moisture during the initiation period reduces tasseling (Berding, 1995). The photo period and temperature are major factors to control transition from vegetative to reproductive growth in grasses and legumes (Aamlid *et al*., 1999).

Managed initiation of flowering of sugarcane in a tropical environment has been advanced considerably by developing an understanding of the environmental variables affecting the flowering process and the management needs of the plants being initiated, and/also by developing an avoidance strategy to circumvent the high temperature events that impact on initiation efficacy under prevailing ambient conditions (Berding and Moore, 1996, 2001; Berding *et al.,* 2004, 2007).

Shanmugavadivu and Gururaja Rao (2009) the reduction in flowering ability of clones in the traditional breeding plots could be due to high temperature prevailing prior to and during the floral initiation period and deficient rainfall. Both night and day time temperatures are important factors in promoting the physiological change from vegetative to reproductive phase in sugarcane (Chris La Borde, 2014). Average daily maximum temperatures during the vegetative, pre-initiation, and boot had a significant effect on tasseling percentage for the overall artificial photo period regimes examined. Critical temperatures identified in this study during the pre-initiation stage (>32.1 °C) and boot stage (>33.1 °C) have identified some weaknesses in the time frame of the artificial photo period regimes (LaBorde *et al.,* 2014).

Maximum temperatures are frequently associated with cloudless skies, lack of rainfall, and low humidity, all of which might lead to water deficiency and drought stress, both of which are known to inhibit flowering (Moore and Berding, 2014). Sugarcane plants different in flowering from plant cane to first ratoon (Mohamed *et al*, 2016). The objectives of these experiments were to study behavior of selected germplasm, its results from sugarcane selection program in Mattana, Luxor, Egypt under natural flowering and make synchronization for crossing.

## MATERIALS AND METHODS

Two experiments were conducted at El-Sabahia Research Station (31° 12 N), Alexandria, Egypt, during 2013/2014/2015 season (plant cane crop) and 2015/2016 season (first ratoon crop). The experimental procedures: Thirty-seven sugarcane genotypes from different origins and three checks commercial GT 54-9, G 84-47 and G 2003-47 were used in this study (Table 1). In the middle of August, 2013 three–budded/cuttings of each genotype were planted in 3 ridge plots. Each row was 5 m long and 1 m apart. Thus, the plot size was 15 m².

The experimental design used was Randomized Complete block with two replications. After flowering season, all plots of 2013 plant-cane were cut in June 14, 2015 and allowed to grow the ratoon in June 14, 2016. The following measurements were recorded three stages as (Mehareb, 2006). Duration of Pre flag leaf stage: This stage was calculated as a number of days from planting date until stopping formation of new leaves and beginning of the flag leaf formation and emergence. Duration of flag leaf stage: was calculated as a number of days from the beginning of flag leaf formation to as soon as the emergence of the inflorescence form flag leaf sheath occurred.

**Duration of emergence stage:** was calculated from the starting of emergence of the inflorescence from flag leaf until its full extension completed. Percent of total flowered plants: number of flowered plants/number of plants per plot × 100. The average daily humidity for five months from July to November for plant cane (2014 season) and first ratoon (2015 season). (figure 1) The number of days for flowering under the optimum temperature (18-31°C) during three month in 2014 and 2015 years. (table 2).

**Statistical analysis:**

An individual analysis of variance for each season as well as a combined analysis for both seasons were conducted according to Snedecor and Cochran (1967). The duration of pre flag leaf stage, duration of flag leaf stage, duration of emergence stage and the percentage values for total flowered stalks, were transformed to the corresponding angle values in degrees ARC-Sin according to Evwin *et al*. (1966). Means were compared using LSD at 5% level of probability according to Waller and Duncan (1969).

## RESULTS AND DISCUSSION

**Effect the humidity on sugarcane flowering:**

The average daily humidity for five months from July to November for plant cane (2014 season) and first ratoon (2015 season) showed in figure 1. Figure 1, presented % of daily humidity for plant cane were higher than first ratoon in all five months, so sugarcane flowering in plant cane (2014/2015) was higher than sugarcane flowering in first ratoon (2015/2016) these results were in agreement with those obtained by (Clement & Awada, 1964, Pereira *et al*, 1983) and Moore & Berding 2014), they reported moisture is more effect on sugarcane flowering. Enough moisture is critical for induction, initiation, time of flowering emergence and seed set (Moore and Nuss 1987). Low moisture during the initiation period reduces sugarcane flowering (Berding 1995).

**Effect the temperature on sugarcane flowering:**

Table (2) presented the number of days for flowering under the optimum temperature (18-31 °C) during three month (induction and initiation stage) from July to September in plant cane and first ratoon, the number of these days in plant cane was 63 days higher than first ratoon (33 days), so flowering for genotypes in plant cane was higher than first ratoon, these results were agreement with those obtained by (Berding and Moore, 1996, 2001; Berding *et al.,* 2004, 2007, Moore and Berding 2014)., they showed high temperature effect on sugarcane flowering. Individual and combined analysis of variance (Tables 3 and 4) over the two seasons, plant cane and first ratoon revealed significant differences among genotypes for all measured characters. The difference between plant cant and first ratoon was significant for all characters. The genotype × year's interaction was significant for all studied characters.

**Duration of pre flag leaf stage**:

This stage was calculated as a number of days from the start of photo period treatments until stopping formation of new leaves and beginning of the flag leaf formation and emergence. Data presented in Table 5 indicated that within genotypes that flowered under plant cane and first ratoon, the duration of pre flag leaf stage varied from as minimum as 382 days for genotype G 2009-22 (Egypt) to as 496 days for genotype NA 56-79 intro used from Argentina. While the within genotypes that flowered under first ratoon the duration of pre flag leaf stage ranged between 239 days for G 2009-22 to 440 days for SP 79-223 (Brazil).

**Duration of flag leaf stage:**

This stage represents the developmental and elongation of the panicle from the end of pre flag leaf stage to the time of panicle emerges from the flag leaf sheath occurred. Data shown in Table 5 showed that plant cane, the lowest duration of this stage was recorded by the genotype M 35-157 from Mauritius (6.5 days), while

the highest duration was recorded by the genotype G 2008-20 (29.5 days) and the other genotypes fell in between. With respect to genotypes that flowered first ratoon this duration ranged from 7 days for four genotypes; PS 80-1424 (Sri Lanka), L61-49 (USA), EI 242-16 (Salvador) and G 2006-36 (Egypt) to 26.5 days for the genotype G 2009-86 (Egypt).

**Duration of emergence stage**

Emergence stage includes the full upward thrust off the inflorescence from the time it just emerges until the full extension of tassel is realized. Data presented in Table 6 presented that within the genotype group that flowered in plant cane this duration varied from 5 days for the genotype Koeng Java (Indonesia) to 18 days for the genotype G 2008-20 ( Egypt), while within the genotype group that flowered under first ratoon, the duration of emergence stage fared from 7 days for three germplasm/s; SP 79-2233 (Brazil), G 2009-11 (Egypt) and EI 242-16 (Salvador) to 19.5 days for promising variety G 2004-27 (Egypt).

**Percentage of total flowered**

Data in table 6 showed the percentage (%) of total flowered plants was significant under plant cane ranged from 12% for two germplasm/s; SP72-5181 (Brazil) and G2008-20 (Egypt) to 65% for G2009-22 (Egypt). While, % of total flowered plants was significant under first ratoon varied from 11.40% for promising variety G2004-27 (Egypt) to 61.5% for genotype NA 56-79 (Argentina). Within the genotype group that flowered under both plant cane and first ratoon, results indicated that, under plant cane and first ratoon the duration of pre flag leaf stage, the duration of flag leaf stage, Duration of emergence stage and Percentage of total flowered the for fourteen genotypes were, i.e., EI8-129, M35-157, PS80-1424, K81113, L61-49, NA56-79, SP79-2233, G2009-11, G2009-10, G2009-22, G2009-86, G2004-27, G2008-64 and 88/5-27.

Results indicated that, the duration of pre flag leaf stage is much longer than the other flowering stages since it included the time needed for the accumulation of stimulus to divert the meristem from leaf production to reproductive stage, following that, a fairly long period in which no structural change appears but during which the tip of inflorescence undertakes the change from the bilateral arrangement to a spiral arrangement. The breeding stock must be examined to define such response for better utilization of these materials in breeding programs. Flowering behavior of forty sugarcane genotypes when planted in plant cane and first ratoon is presented in Table (7). Results indicated that the forty sugarcane genotypes, tested under plant cane and first ratoon seasons could be classified into four groups. The first group included fourteen genotypes that flowered in plant cane and first ratoon seasons, and these genotypes were: EI8-129, M35-157, PS80-1424, K81113, L61-49, AN56-79, SP79-2233, G2009-11, G2009-10, G2009-22, G2009-86, G2004-27, G2008-64 and 88/5-27. The second group consisted of ten genotypes that flowered only under plant cane. These ten genotypes were: Koeng Java, SP72-5181, G84-68, G84-47, G74-96, G2008-59, G2006-3, G2007-61, GT54-9 and G2008-20.

The third group included two genotypes that flowered only under first ratoon and they were: EI 242-16 and G 2006-36. The fourth group included fourteen genotypes that did not show any response neither plant cane and/nor first ratoon, these genotypes were: CO 775, G2003-47, US 59-161, ROC 10, EI58-28, EI8-10, F 161, L62-96, G2000-5, G99-80, SP80-3250, SP80-1842, G2003-49 and Mex 2001-80. Therefore, the forty evaluated sugarcane geno-types varied considerably among themselves in their response to flowering under plant cane and first ratoon.

**CONCLUSION**

Flowering for genotypes in plant cane was higher than first ratoon because percentage of daily humidity for plant cane (2014) were higher than first ratoon (2015) during flowering stages and the number of days for flowering under the optimum

temperature (18-31 °C) during three month (induction and initiation stage) in plant cane was 63 days higher than first ratoon (33 days), all those factors was reasons of flowering in plant cant was higher than first ratoon, so a better understanding of temperature and relative humidity effects on sugarcane flowering is important to study behavior of genotypes flowering and make synchronization for crossing in future between these genotypes.

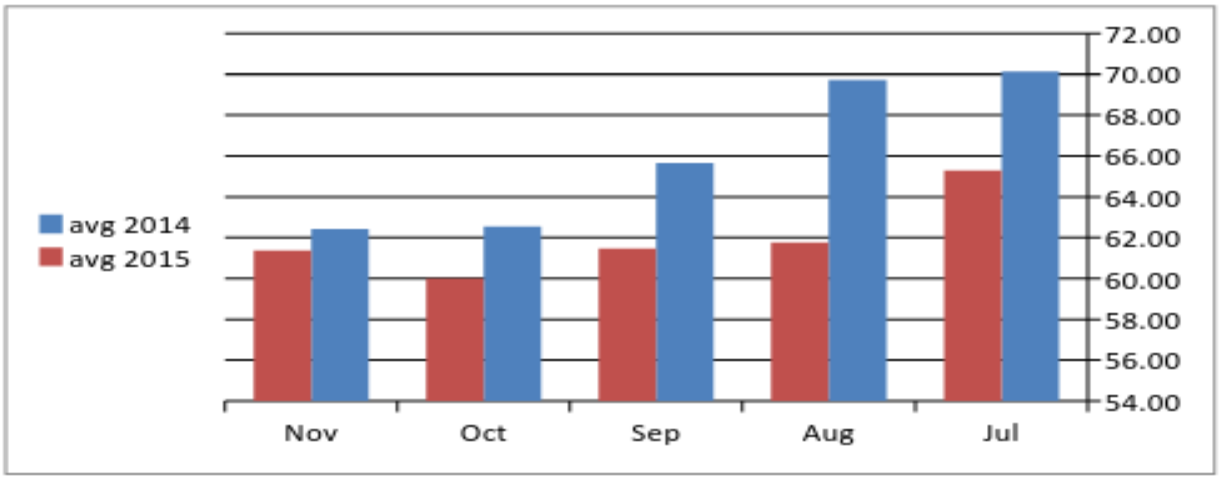


**Fig. 1. The average daily humidity for five months from July to November for plant cane (2014 season) and first ratoon (2015 season).**

**Table-1 Source country of sugarcane genotypes studied**

| Sr. No. | Genotype | Source | Sr. No. | Genotype | Source |
|---|---|---|---|---|---|
| 1 | CO 775 | India | 21 | SP 72-5181 | Brazil |
| 2 | Koeng Java | Indonesia | 22 | G 84-68 | Egypt |
| 3 | G2003-47 | Egypt | 23 | G 84-47 | Egypt |
| 4 | EI 8-129 | Salvador | 24 | SP 79-2233 | Brazil |
| 5 | US 59-161 | South Florida | 25 | G 74-96 | Egypt |
| 6 | M35-157 | Mauritius | 26 | G 2003-49 | Egypt |
| 7 | ROC 10 | Taiwan | 27 | G 2009-11 | Egypt |
| 8 | EI 58-28 | Salvador | 28 | Mex 2001-80 | Mexico |
| 9 | EI 8-10 | Salvador | 29 | G 2009-10 | Egypt |
| 10 | EI 242-16 | Salvador | 30 | G 2009-22 | Egypt |
| 11 | PS 80-1424 | Sri Lanka | 31 | G 2009-86 | Egypt |
| 12 | F 161 | Taiwan | 32 | G 2006-36 | Egypt |
| 13 | K 81113 | Thailand | 33 | G 2008-59 | Egypt |
| 14 | L 62-96 | Lousiana | 34 | G 2006-3 | Egypt |
| 15 | L 61-49 | Lousiana | 35 | G 2004-27 | Egypt |
| 16 | G 2000-5 | Egypt | 36 | G 2007-61 | Egypt |
| 17 | G 99-80 | Egypt | 37 | GT 54-9 | Egypt |
| 18 | SP 80-3250 | Brazile | 38 | G 2008-20 | Egypt |
| 19 | NA 56-79 | Argentina | 39 | G 2008-64 | Egypt |
| 20 | SP 80-1842 | Brazile | 40 | 88/5-27 | Egypt |

**Table-2 The number of days for flowering under the optimum temperature (18-31°C) during three month in 2014 and 2015 years**

| No. of days | | Month |
|---|---|---|
| **2015** | **2014** | |
| 22 | 25 | July |
| 2 | 14 | August |
| 9 | 24 | September |
| 33 | 63 | Total |

**Table-3 Analysis of variance for the studied traits under plant cane and first ratoon**

| Flag | | Pre flag | | df | S.O.V. |
|---|---|---|---|---|---|
| **First ratoon** | **Plant cane** | **First ratoon** | **Plant cane** | | |
| 0.8 | 68.45 | 49.613 | 644.11 | 1 | Replication |
| 103.441** | 158.963** | 57708.256** | 99725.27** | 39 | Genotypes |
| 2.005 | 3.117 | 8.151 | 17.34 | 39 | Error |
| **% Flowered plant** | | **Emergence** | | | |
| **First ratoon** | **Plant cane** | **First ratoon** | **Plant cane** | | |
| 29.258 | 112.813 | 11.25 | 16.2 | 1 | Replication |
| 794.385** | 786.082** | 58.358** | 47.717** | 39 | Genotypes |
| 1.604 | 3.838 | 0.788 | 0.995 | 39 | Error |

**Table-4 Combined analysis of variance over two seasons (plant cane and first ratoon) for the studied traits**

| % Flowered plant | Emergence | Flag | Pre Flag | d.f | S.O.V. |
|---|---|---|---|---|---|
| 666.75 | 40.00 | 483.03 | 729810.23 | 1 | Year |
| 71.04 | 13.73 | 34.63 | 346.86 | 2 | Error |
| 1442.81** | 70.90** | 164.58** | 106742.43** | 39 | Genotypes |
| 137.66** | 35.18** | 97.82** | 50691.10** | 39 | Y x G |
| 2.72 | 0.89 | 2.56 | 12.75 | 78 | Error |

**Table-5 Duration of pre flag leaf stage and duration of flag leaf stage**

| Duration of flag leaf stage | | Duration of pre flag leaf stage | | Genotype |
|---|---|---|---|---|
| **First ratoon** | **Plant cane** | **First ratoon** | **Plant cane** | |
| 15.00 | 15.00 | 240.00 | 400.00 | EI 8-129 |
| 15.00 | 6.50 | 310.00 | 451.00 | M35-157 |
| 7.00 | 29.00 | 302.00 | 422.00 | PS 80-1424 |
| 12.00 | 10.50 | 363.00 | 493.00 | K 81113 |
| 7.00 | 10.00 | 395.00 | 495.00 | L 61-49 |
| 11.00 | 9.50 | 344.00 | 496.00 | AN 56-79 |
| 9.00 | 27.50 | 440.00 | 414.50 | SP 79-2233 |
| 21.00 | 16.00 | 349.50 | 435.00 | G 2009-11 |
| 13.00 | 13.00 | 260.50 | 402.00 | G 2009-10 |
| 13.00 | 13.00 | 239.00 | 382.00 | G 2009-22 |

| | | | | |
|---|---|---|---|---|
| 26.50 | 7.50 | 263.00 | 415.00 | G 2009-86 |
| 8.50 | 12.00 | 336.00 | 430.00 | G 2004-27 |
| 16.00 | 12.00 | 255.50 | 383.00 | G 2008-64 |
| 16.00 | 10.00 | 384.00 | 464.00 | 88/5-27 |
| - | 10.00 | - | 490.00 | SP 72-5181 |
| - | 27.50 | - | 422.00 | G 84-68 |
| - | 20.00 | - | 465.00 | G 84-47 |
| - | 12.00 | - | 480.00 | G 74-96 |
| - | 10.00 | - | 435.00 | G 2008-59 |
| - | 11.00 | - | 485.00 | G 2006-3 |
| - | 13.00 | - | 460.00 | G 2007-61 |
| - | 7.50 | - | 474.00 | GT 54-9 |
| - | 29.50 | - | 424.00 | G 2008-20 |
| - | 11.00 | - | 495.00 | Koeng Java |
| 7.00 | - | 433.00 | - | EI 242-16 |
| 7.00 | - | 395.00 | - | G 2006-36 |
| - | - | - | - | G 2003-49 |
| - | - | - | - | Mex 2001-80 |
| - | - | - | - | CO 775 |
| - | - | - | - | G2003-47 |
| - | - | - | - | US 59-161 |
| - | - | - | - | ROC 10 |
| - | - | - | - | EI 58-28 |
| - | - | - | - | EI 8-10 |
| - | - | - | - | F 161 |
| - | - | - | - | L 62-96 |
| - | - | - | - | G 2000-5 |
| - | - | - | - | G 99-80 |
| - | - | - | - | SP 80-3250 |
| - | - | - | - | SP 80-1842 |
| 0.640 | 0.790 | 1.291 | 1.880 | LSD 0.05 |
| | | 1.88 | 4.2 | LSD 0.05 (G X Y) |

**Table-6 Duration of emergence stage and percentage of total flowered plants**

| % of total flowered plants | | Duration of emergence stage | | Genotype |
|---|---|---|---|---|
| First ratoon | Plant cane | First ratoon | Plant cane | |
| 29.50 | 35.00 | 8.50 | 7.00 | EI 8-129 |
| 56.25 | 60.00 | 14.00 | 8.00 | M35-157 |
| 43.35 | 44.00 | 13.00 | 6.00 | PS 80-1424 |
| 33.40 | 25.00 | 8.00 | 7.00 | K 81113 |
| 20.00 | 19.00 | 10.00 | 6.50 | L 61-49 |
| 61.50 | 45.00 | 8.00 | 6.00 | AN 56-79 |
| 29.25 | 26.00 | 7.00 | 14.00 | SP 79-2233 |
| 43.00 | 50.00 | 7.00 | 6.00 | G 2009-11 |
| 35.64 | 41.00 | 10.00 | 7.50 | G 2009-10 |
| 52.45 | 65.00 | 8.50 | 7.00 | G 2009-22 |
| 38.25 | 40.00 | 7.50 | 15.00 | G 2009-86 |
| 11.40 | 15.00 | 19.50 | 9.50 | G 2004-27 |
| 47.40 | 49.50 | 11.00 | 7.50 | G 2008-64 |

| | | | | |
|---|---|---|---|---|
| 33.35 | 40.50 | 12.00 | 7.00 | 88/5-27 |
| - | 12.00 | - | 8.00 | SP 72-5181 |
| - | 25.50 | - | 14.00 | G 84-68 |
| - | 14.00 | - | 6.50 | G 84-47 |
| - | 20.50 | - | 8.00 | G 74-96 |
| - | 42.00 | - | 6.00 | G 2008-59 |
| - | 23.00 | - | 6.50 | G 2006-3 |
| - | 13.00 | - | 7.00 | G 2007-61 |
| - | 13.00 | - | 8.00 | GT 54-9 |
| - | 12.00 | - | 18.00 | G 2008-20 |
| - | 12.50 | - | 5.00 | Koeng Java |
| 22.25 | - | 7.00 | - | EI 242-16 |
| 22.20 | - | 10.00 | - | G 2006-36 |
| - | - | - | - | G 2003-49 |
| - | - | - | - | Mex 2001-80 |
| - | - | - | - | CO 775 |
| - | - | - | - | G2003-47 |
| - | - | - | - | US 59-161 |
| - | - | - | - | ROC 10 |
| - | - | - | - | EI 58-28 |
| - | - | - | - | EI 8-10 |
| - | - | - | - | F 161 |
| - | - | - | - | L 62-96 |
| - | - | - | - | G 2000-5 |
| - | - | - | - | G 99-80 |
| - | - | - | - | SP 80-3250 |
| - | - | - | - | SP 80-1842 |
| 0.573 | 0.880 | 0.402 | 0.450 | LSD 0.05 |
| | | 1.94 | 1.11 | LSD 0.05 (G X Y) |

**Table-7 Distribution of the tested genotypes according to their flowering response under plant cane and first ratoon**

| Sr. No. | Flowering in both season | Flowering in first ratoon | Flowering in Plant cane | No flowering |
|---|---|---|---|---|
| 1 | EI 8-129 | EI 242-16 | 1-Koeng Java | CO 775 |
| 2 | M35-157 | G 2006-36 | 2-SP 72-5181 | G2003-47 |
| 3 | PS 80-1424 | | 3-G 84-68 | US 59-161 |
| 4 | K 81113 | | 4-G 84-47 | ROC 10 |
| 5 | L 61-49 | | 5-G 74-96 | EI 58-28 |
| 6 | NA 56-79 | | 6-G 2008-59 | EI 8-10 |
| 7 | SP 79-2233 | | 7-G 2006-3 | F 161 |
| 8 | G 2009-11 | | 8-G 2007-61 | L 62-96 |
| 9 | G 2009-10 | | 9-GT 54-9 | G 2000-5 |
| 10 | G 2009-22 | | 10-G 2008-20 | G 99-80 |
| 11 | G 2009-86 | | | SP 80-3250 |
| 12 | G 2004-27 | | | SP 80-1842 |
| 13 | G 2008-64 | | | G 2003-49 |
| 14 | 88/5-27 | | | Mex 2001-80 |

**REFERENCES**

Aamlid, T.S., O.M. Heide, B.R. Christie, and R.L. McGraw. 1999. Reproductive development and the establishment of potential seed yield in grasses and legumes. Pp. 17-44. *In* D.T. Fairey and J.G. Hampton (ed.) Forage Seed Production 1. Temperate Species. CAB International, New York, NY.

Berding, N. 1995. Improving flowering through breeding: progress and prospects. Proc. Queensland Sugar Technol. Assoc. 17:162-171.

Berding N, Moore PH 1996. Towards optimised induction of flowering in sugarcane. In 'Sugarcane: Research towards efficient and sustainable production' (Eds JR Wilson, DM Hogarth, JA Campbell, AL Garside) pp. 44–46. (CSIRO Division of Tropical Crops and Pastures, Brisbane).

Berding N, Moore PH 2001. Advancing from opportunistic sexual recombination in sugarcane: Lessons from tropical photoperiodic research. *Proceedings of theInternational Society of Sugar Cane Technologists* 24, 482–487.

Berding N, Dunne V, Swain RS, Owens WG 2004. Tropical, managed initiation of sugarcane flowering: optimisation of non-photoperiodic variables. *Proceedings of the Australian Society of Sugar Cane Technologists* 26, (CD-ROM) 13 pp.

Berding N, Pendrigh RS, Dunne V 2007. Can flowering in sugarcane be optimized by use of differential declinations for the initiation and development phases? *Proceedings of the International Society of Sugar Cane Technologists* 27, 699–711.

Clements, H. F. and Awada, M. 1964. Factors affecting the flowering of sugarcane. Ind. J. Sugarcane Res. and Dev., 8 (2): 140-159.

Clements, H. F. and M. Awada. 1967. Experiments on the artificial induction of flowering in sugarcane. Proc. Int. Soc. Sugar Cane Technol. 12:795-812.

Coleman, R.E. 1968. Physiology of flowering in sugarcane. *Proceedings International Society of Sugar Cane Technologists*, 13, 992–1000.

Evwin, L. L.; H. L. Warren and G.C. Andrews 1966. "Field plot technique" transformation of experimental data. Burgess pub. Comp America, p. 338-349.

LaBorde CM 2007. Sugarcane tasseling under artificial photo period conditions as affected by nitrogen rate and temperature. 84f. Dissertation Submitted to the Graduate Faculty of the Louisiana State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

LaBorde Chris, Collins Kimbeng, Kenneth Gravois, and Keith Bischoff 2014. Temperature Effects on Sugarcane Tassel Production under Artificial Photo period Regimes. Journal of American Society of Sugar Cane Technologists, Vol. 34, 33-43.

Mehareb, E. M 2006. Response of some sugarcane genotypes to artificial and natural flower induction. Dissertation Submitted to the Graduate Faculty of Agriculture, Cairo University in partial fulfillment of the requirements for the degree of Master of Science.

Mohamed, B. D., Mahmoud, E. A., El-Hennawi, H. H. and Mehareb, E. M. 2016. Sugarcane Flowering in Relation to Nitrogen Fertilization and Ratoon. Direct Research Journal of Agriculture and Food Science. Vol.4 (7), pp. 155-160.

Moore P. H. and Nils Berding 2014. Flowering. Chapter 15 in Sugarcane: Physiology, Biochemistry, and Functional Biology book.

Moore, P.H. and K.J. Nuss. 1987. Flowering and flower synchronization. Pp. 102-127. *In* D.J. Heinz (ed.) Sugarcane Improvement Through Breeding. Elsevier Press, Amsterdam, The Netherlands.

Nuss KJ, Brett PGC 1977. Artificial induction of flowering in a sugarcane breeding programme. Proc. South. Afr. Genet. Soc 6: 54-64.

Pereira, A.R.V. Bardiere and N.A. Villanova 1983. Climatic conditioning of flower Induction in sugarcane. Agric. Meteorol. 29: 103-110.

Restrepo, F.S. and J.H. Ranjel 1984. Induction and Synchronization of sugarcane flowering in the Cauca Valley. Acta-agronomica, 34 (2): 20-25.

Shanmugavadivu R. and P. N. Gururaja Rao 2009. A comparison of flowering behaviour of sugarcane clones in two different Locations. Sugar Tech 11(4): 401-404.

Snedecor, G.V. and W.G. Cochran 1967. Statistical methods. Sixth Ed. Iowa State Univ. Pross Ames Lawa, USA.

Waller, R.A. and D. B. Duncan 1969. A bays rule for the symmetric multiple comparison problem. Amr. State. Assoc. J. Dec.:1485-1503.

# COMPARATIVE EVALUATION OF SOME SUGARCANE GENOTYPES FOR CANE YIELD AND QUALITY ATTRIBUTES IN ADVANCED VARIETAL TRIAL

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## ABSTRACT

A comparative study was conducted to evaluate the performance of eight newly developed sugarcane genotypes against the standard variety Thatta-10 in advanced varietal trial. The experiment was laid out according to a randomized complete block design (RCBD) with three replications. All sugarcane genotypes exhibited different behavior with regard to cane yield and Commercial Cane Sugar Percentage (CCS%). The genotype Thatta-910 exhibited highest cane yield (112.50 t $ha^{-1}$) and CCS (13.71%) against Thatta-10 (Cane yield 100.0 t $ha^{-1}$ and CCS 12.85%). While, rests of the genotypes in the trial could not surpass the standard variety in terms of cane yield and CCS%. It is suggested that the genotype Thatta-910 should be further tested for cane yield and quality performance under different agro-climatic conditions of Sindh to draw out its substantial conclusion.

**Key words:** ***Sugarcane genotypes, cane yield, yield components, CCS%, Thatta***

## INTRODUCTION

Sugarcane, in Pakistan, keeps the place of second major cash crop and it is source of raw material for the manufacture of white sugar (Khan *et al*., 2010 and Junejo *et al*., 2010). In Pakistan, it is grown on about one million hectares area and base of raw material to 84 sugar mills and confers employment to many individuals as well as source of income for farming community (Soomro *et al*., 2016). In addition to this, it produces several economically viable byproducts such as alcohol for pharmaceutical industries, ethanol for fuel production, pressmud for organic matter and nutrient source in crop production and baggase for manufacture of chip board and papers (Khan *et al*., 2013).

The area under sugarcane cultivation in Pakistan has increased manifold and now it is being grown on area of 1, 171, 687 hectares with total annual production of 67,427,975 tones (PSMA-SZ 2015). Although our domestic sugarcane production and sugar recovery has enhanced steadily with the passage of time, yet our national average cane yield is 57.55 t $ha^{-1}$ and average sugar recovery is 9.90% (PSMA-SZ 2015), which is very low than the production potential of 200 t $ha^{-1}$ and sugar recovery of 12% in the indigenous varieties available in the commercial pool. In spite of distinct progression in sugarcane research and speedy growth in sugar industry, low cane yield and sugar recovery is being recorded in Pakistan. In addition to this, high cost of cultivation is the foremost concern being faced by farmers. One of the solutions recommended to counteract these problems is planting of advanced cane varieties (Chattha and Eshsanullah, 2003; Chattha *et al*., 2006 and Kadam *et al*., 2007). The achievement of a variety relies upon its adaptability to specific agro-climatic conditions of the region to be aware of maximum yield. The selection of variety alone makes better the cane yield in the range of 28-60 per cent (Kathiresan *et al*., 2001).

The promising varieties adapted to different climatic conditions have been reported from time to time by many workers (Mari *et al*., 2011; Chohan *et al*., 2007;

Kaloi *et al*., 2007 and Chattha *et al*., 2004) these varieties have a large adoptability and being successfully grown throughout the areas. But still there is need to add new potential varieties in the exiting commercial pool.

Most of the sugarcane varieties under commercial cultivation are getting obsolete and losing their production potential with the passage of time, therefore, a large number of sugarcane varieties were slowly phased out due to their unstable productive behavior under various biotic and abiotic stresses. Thus in the existing level, evaluation of new sugarcane varieties bearing higher cane and sugar yield potential is the need of the time for sustaining cane and sugar productivity as well as betterment of growers and millers. Keeping in view the basic and highly important aspect of grower and millers, the study was conducted to evaluate the best suitable sugarcane varieties for commercial cultivation in Sindh.

## MATERIALS AND METHODS

The study was carried out at National Sugar and Tropical Horticulture Research Institute, PARC, Makli, Thatta, during 2011-12. Eight promising sugarcane genotypes viz. Thatta-903, Thatta-907, Thatta-910, Thatta-911, Thatta-912, Thatta-913, Thatta-914 and Thatta-920 developed from local sugarcane fuzz were tested in advanced varietal trial for their cane yield, yield components and quality parameters against commercial variety Thatta-10 in an experiment laid out in randomized complete block design (RCBD) with three replications and a plot consists of five rows of six meter length spaced one meter apart. A seed rate of 30,000 three budded setts/ha was followed. The soils of the experimental site were characterized by clay loam with pH (7.6), EC (1.3 d $Sm^{-1}$), poor available nitrogen (0.05%), low available phosphorus (3.90 mg $kg^{-1}$) and adequate exchangeable potassium (227 mg $kg^{-1}$).

Recommended dosage (230:115:125 kg $ha^{-1}$) of N: $P_2O_5$: $K_2O$ fertilizers were applied in the form of Urea, TSP and SOP. All phosphorus, potassium and 1/3 nitrogen were applied as basal dose at the time of planting, whereas remaining nitrogen was applied in two equal splits at 45 and 90 days after planting. All other agronomic practices, *viz*. weeding and earthing up, etc as well as insect pest and disease control measures were taken as per recommendation.

Irrigations were given as and when necessary as per crop water requirements. The data on cane yield, yield components, *viz*. cane thickness, cane height, number of internodes per plant and number of millable canes were recorded at harvest. Five canes of each sugarcane genotype were randomly selected from each plot for juice analysis. Juice quality parameters, *viz*. Fiber %, Brix %, Pol %, Purity% and Commercial Cane Sugar Percentage (CCS %) were recorded at harvest by following standard procedures (Spencer and Mead 1963). Data collected were analyzed statistically using computer software (MSTAT-C software 1991).

## RESULTS

Mean squares computed through analysis of variance are presented in Table-1 indicated that there were highly significant ($P \leq 0.01$) differences among the genotypes for cane thickness, cane height, number of internodes $plant^{-1}$ and cane yield, while significant ($P \leq 0.05$) differences were observed for millable canes.

Mean performance of the genotypes for cane yield and yield components is depicted in Table-3 which revealed that genotypes Thatta-910 showed excel in cane thickness and remained statistically at par with check variety Thatta-10. While, the genotypes Thatta-907, Thatta-911 and Thatta-920 exhibited significantly lowest cane thickness and remained statistically similar to each other. In case of cane height, the genotypes Thatta-910, Thatta-912 and Thatta-913 were statistically at par with maximum cane height as compared to Thatta-10, while, the genotypes Thatta-903 and Thatta-907 produced significantly next better cane

height as compared to check variety. In contrast, the lowest cane height was exhibited in Thatta-914. The number of internodes plant$^{-1}$ were significantly higher in Thatta-913 followed by Thatta-912, Thatta-920, Thatta-910 and Thatta-903 with comparatively next better performance and surpassed Thatta-10 in terms of number of internodes plant$^{-1}$. The data regarding millable canes revealed that the genotype Thatta-910 maintained its superiority by producing significantly maximum millable canes, while, the genotypes Thatta-912, Thatta-911, Thatta-903, Thatta-913 and Thatta-907 displayed significantly next better performance in terms of millable canes and remained statistically similar to Thatta-10. In case of cane yield, the genotype Thatta-910 showed dominance over Thatta-10. While, rests of the genotypes in the trial could not out yield the check variety.

Mean squares computed through analysis of variance for quality parameters presented in Table-2 indicated that there were highly significant ($P \leq 0.01$) differences among the genotypes for fiber %, brix %, Pol%, purity % and CCS %. Mean performance of the genotypes for CCS and other quality parameters is depicted in Table-4 which revealed that the genotypes Thatta-903, Thatta-907, Thatta-911, Thatta-912, Thatta-914 and Thatta-920 exhibited statistically similar results and appeared to be highly fibrous content genotypes. While, the genotypes Thatta-910, Thatta-913 and check variety Thatta-10 produced comparatively less fiber percentage and remained statistically identical to each other. In case of brix content, check variety Thatta-10 and Thatta-903 remained statistically at par with significantly maximum brix % followed by Thatta-912 and Thatta-910. The data in Table-4 further revealed that the genotype Thatta-910 and check variety Thatta-10 remained statistically at par with significantly maximum Pol% followed by Thatta-913 and Thatta-913. Moreover, the genotype Thatta-914 produced statistically minimum Pol % followed by Thatta-920, Thatta-907, Thatta-911 and Thatta-903 with statistically similar results. As regards purity %, check variety Thatta-10 and Thatta-910 remained statistically at par with maximum Pol % followed by Thatta-913 and Thatta-907. While, the genotypes Thatta-914 and Thatta-912 exhibited significantly lowest results with statistically similar Pol%.

Maximum purity (84.08 %) was produced by Thatta-910 followed by Thatta-913, Thatta-10 and Thatta-907 with purity of 80.75, 80.13 and 78.17 %, respectively. In case of commercial cane sugar percentage (CCS), the genotype Thatta-910 surpassed all the genotypes by producing significantly maximum CCS % followed by check variety Thatta-10 and Thatta-913. Moreover, CCS % in rests of the genotype was lower than that of check variety.

## DISCUSSION

Cane yield and sugar percent in the juice are two main characters of foremost importance, for which sugarcane is cultivated on a commercial level. Acceptance of a new sugarcane variety at farmer's level requires to have high cane yield potential, while, for sugar mills it must contains high sugar percent. Therefore, for improving the cane and sugar production of the crop, the sugarcane breeders are continually looking for the varieties possessing inherent capability to produce better cane yield and sugar recovery, mutually beneficial to all stakeholders.

Cane yield and its components are the main traits in sugarcane production, of which stalk weight and number of millable canes are two major parameters of cane yield (Okaz *et al*., 2011). The highest cane yield in sugarcane variety Thatta-910 as compared to other sugarcane genotypes in the trial may be associated to the production of thicker, taller cane stalks and sufficient number of millable canes per hectare. These results are further supported by (Khan *et al*., 2002) who reported that increase in cane yield of sugarcane might be due to maximum plant height, weight per stool and cane girth. Naidu *et al*. (2007) stated that plant height and cane girth are known to be the major

contributing factors for high cane yield. According to Hossain and Islam (2008) stalk diameter plays a significant role for cane weight and cane yield. Khalid *et al*. (2010) reported that number of tillers is playing a main part in raising the final yield of sugarcane. In case of quality, maximum Commercial Cane Sugar (CSS%) in variety Thatta-910 was due to less fiber content and more purity percentage.

Kent *et al*. (2010) reported that sugar recovery reduces by about 0.9 units for each 1 unit increase in cane fiber content. Furthermore, the sugarcane genotypes in this trial exhibited varying behaving trend with regard to cane yield, yield components and CCS %. The difference among the genotypes for these traits may be attributed to their inherent genetic makeup and response to environmental factors in which they were grown (Okaz *et al*., 2011). Similarly Abo-El-Hamd *et al*. (2013) confirmed that commercial cane varieties are inter-specific hybrids and thus vary in their yield and quality characteristics because of great inequality in their genetic composition. Mari *et al*. (2011) stated that genetically superior genotypes might have aptitude to generate satisfactory results for per hectare yield and sugar percentage under particular set of environmental conditions. El-Geddaway *et al*. (2002) and Panhwar *et al*. (2008) were of this view that sugarcane varieties are highly influenced by genetic makeup.

According to Keerio *et al* (2003) unless the genetic capabilities of a variety are high, mere provisions of growing conditions such as manuring, irrigation etc. will not lead to substantial improvement in cane or sugar content. Similarly Sohu *et al* (2008) stated that cane yield per hectare is a product of well-matched interaction of genetic as well as environmental factors towards the growth and development of the sugarcane plant. Hence, it is also presumed that the highest cane yield and CCS% in Thatta-910 as compared to other sugarcane genotypes might be due to its inherent genetic potential and more efficient utilization of existing resources under given set of environmental conditions towards its economic production.

## CONCLUSION

It is concluded that sugarcane genotype Thatta-910 can provide better economic returns to the farming community as well as sugar mills due to its better cane yield and sugar content capacity. Therefore, the same variety is recommended for further testing in terms of cane yield and quality as well as its stability under different agro-climatic zones of Sindh.

**Table-1 Mean squares from analysis of variance for cane yield and yield components of sugarcane genotypes in advanced varietal trial during 20011-12**

| Source | DF | Cane Thickness | Cane Height | Number of Internodes | Millable Canes | Cane Yield |
|---|---|---|---|---|---|---|
| Replications | 2 | 0.19340 | 1411.98 | 17.3415 | 577.778 | 650.93 |
| Treatments | 8 | 5.20410 ** | 2100.92 ** | 25.9083 ** | 362.500 * | 1244.16 ** |
| Error | 16 | 0.48188 | 843.46 | 5.3171 | 325.694 | 167.33 |

*Significant ** Highly Significant

**Table-2 Mean squares from analysis of variance for CCS and quality parameters of sugarcane genotypes in advanced varietal trial during 20011-12**

| Source | DF | Fiber | Brix | Pol | Purity | CCS |
|---|---|---|---|---|---|---|
| Replications | 2 | 3.61507 | 4.35444 | 9.30250 | 679.471 | 3.85468 |
| Treatments | 8 | 1.11298** | 1.08333** | 2.11943** | 66.316** | 2.74538** |
| Error | 16 | 0.27387 | 0.14694 | 0.17550 | 17.293 | 0.15888 |

** Highly Significant

**Table-3 Cane yield and yield components of different sugarcane genotypes in advanced varietal trial (plant crop) at NSTHRI, Thatta during 2011-12**

| Genotypes | Cane thickness (mm) | Cane height (cm) | Number of internodes plant$^{-1}$ | Millable canes 000 ha$^{-1}$ | Cane yield (t ha$^{-1}$) |
|---|---|---|---|---|---|
| Thatta-903 | 23.74 cd | 251.66 ab | 24.88 abc | 101.67 ab | 78.33 bcd |
| Thatta-907 | 23.59 d | 238.89 ab | 23.10 c | 95.00 ab | 62.50 de |
| Thatta-910 | 26.98 a | 266.33 a | 25.66 abc | 121.67 a | 112.50 a |
| Thatta-911 | 23.41 d | 223.88 abc | 22.55 c | 103.33 ab | 68.33 cde |
| Thatta-912 | 23.86 bcd | 259.67 a | 27.21 ab | 106.67 ab | 83.33 bcd |
| Thatta-913 | 25.04 b | 259.11 a | 27.99 a | 96.67 ab | 90.00 bc |
| Thatta-914 | 24.81 bc | 190.00 c | 18.22 d | 85.00 b | 55.00 e |
| Thatta-920 | 23.36 d | 203.22 bc | 26.10 abc | 88.33 b | 53.33 e |
| Thatta-10 | 26.24 a | 236.22 abc | 23.95 bc | 106.67 ab | 100.00 ab |
| CV% | 2.83 | 12.28 | 9.45 | 17.95 | 16.55 |
| LSD 0.05 | 1.20 | 50.26 | 3.99 | 31.23 | 22.39 |
| LSD 0.01 | 1.65 | 69.26 | 5.49 | NS | 30.84 |

**Table-4 Quality parameters of different sugarcane genotypes in advanced varietal trial (plant crop) at NSTHRI, Thatta during 2011-12**

| Genotypes | Fiber% | Brix% | Pol% | Purity% | CCS% |
|---|---|---|---|---|---|
| Thatta-903 | 13.28 a | 22.7 a | 17.12 bc | 75.41 bc | 11.29 d |
| Thatta-907 | 13.33 a | 21.4 cd | 16.73 bc | 78.17 ab | 11.35 d |
| Thatta-910 | 12.19 b | 22.5 ab | 18.92 a | 84.08 a | 13.71 a |
| Thatta-911 | 13.20 a | 21.8 cd | 16.75 bc | 76.83 bc | 11.22 d |
| Thatta-912 | 13.36 a | 22.6 ab | 17.19 b | 70.06 c | 11.42 d |
| Thatta-913 | 12.40 b | 21.3 d | 17.20 b | 80.75 a | 12.11 c |
| Thatta-914 | 13.55 a | 21.6 cd | 16.42 c | 70.01 c | 10.90 d |
| Thatta-920 | 13.61 a | 22.0 bc | 16.60 bc | 75.45 bc | 10.94 d |
| Thatta-10 | 12.21 b | 22.9 a | 18.35 a | 80.13 a | 12.85 b |
| CV% | 4.04 | 1.74 | 2.43 | 5.42 | 3.39 |
| LSD 0.05 | 0.90 | 0.66 | 0.72 | 3.39 | 0.68 |
| LSD 0.01 | 1.24 | 0.91 | 0.99 | 9.91 | 0.95 |

**REFERENCES**

Khan, I.A., S. Bibi, S. Yasmin, A. Khatri, N Seema and S. Afghan. 2010. Study of genetic variability in mutated population of sugarcane clone NIA-98 through molecular markers (RAPD and TRAP). Pak. J. Bot., 42(1): 605-614.

Junejo, S., G. M. Kaloi, R. N. Panhwar, M. Chohan, A. A. Junejo and A.F. Soomro. 2010. Performance of some newly developed sugarcane genotypes for some quantitative and qualitative traits under Thatta conditions. The J. Anim. Plan Sci. 20(1): 40-43.

Soomro, A. F., N. A. Soomro, A. A. Kolachi, R. N. Panhwar and M. A. Rajput. 2016. Effect of different organic mulches on the cane yield and recovery in sugarcane. Sci. Int. 28 (2):1285-1289.

Khan, I. A., N. Seema, S. Raza, S. Yasmine and S. Bibi. 2013. Environmental interactions of sugarcane genotypes and yield stability analysis of sugarcane. Pak. J. Bot., 45(5): 1617-1622.

Annual Report 2014-15. Pakistan Sugar Mills Association Sindh Zone (PASMA-SZ). P. 17-20.

Chattha M. U. and Eshsanullah. 2003 Agro-quantitative and qualitative performance of different cultivars and strains of sugarcane. Pak Sug J. 18 (06): 2-5.

Chattha A. A., M. Rafique, M. Afzal, F. Ahmed and M. Bilal. 2006. Prospects of sugar industry and sugarcane cultivation in Punjab. Proc Annu Conv Pak Soc Sug Technol 41:173-181.

Kadam U. A., S. M. More, B. S. Kadam and V. N. Nale. 2007. Growth, yield and quality performance of promising sugarcane genotypes under pre-seasonal condition in Maharashtra. Indian Sugar, 23-28.

Kathiresan G., M. L. Manoharan, K. Duraiswamy and S. Paneerselvam. 2001. Yield gap bridging in sugarcane. Kissan World, 28(2): 25-26.

Mari, A. H., R. N. Panhwar, G. M. Kaloi, G. S. Unar, S. Junejo, M. Chohan and A. W. Jagirani. 2011. Evaluation of some new sugarcane varieties for cane yield and quality in different agro-ecological zones of Sindh. Pak J. Sci. 63 (1):32-36.

Chohan, M., R. N. Panhwar., D. B. Panhwar., M. A. Memon., G. S. Unar and A. H. Mari. 2007. Performance of some new sugarcane varieties for cane yield and quality under different agro-climatic conditions of Sindh. Pakistan J. Sci. Res. 59 (1-2): 28-33.

Kaloi, G. M., D. B. Panhwar., R. N. Panhwar, G. S. Unar., A. H. Mari and M. A. Bhutto. 2007. Genetic behavior of different promising sugarcane varieties for yield and yield contributing characters under agro-climatic conditions of Matiari, Sindh. Pak Sug J. 22(6): 7-77.

Chattha, A. A., M. A. Iqbal, F. Ahmed and M. U. Chattha. 2004. CPF-243 an early maturing, high yielding and high sugar variety. Pak Sug J. 14: 25-27.

Spencer, E. F. and G. P. Meade. 1963. Cane Sugar Hand Book. John Willey and sons. 9th edition, New York, U.S.A.

MSTAT-C software, 1991. Micro computer statistical programme, Michigan State University, USA.

Okaz, A. M., B. D. Mohammad, S. H. M. Abd-El-Haleem and E. M. M. Yousif. 2011. Stability parameters of cane yield and its components under various planting dates and interrow spacings

for ten sugarcane genotypes (*Saccharum* Spp.). Amarican_Eurasian J. Agric. & Environ. Sci. 11(6):929-937.

Khan, I. A., A. Khatri., M. A. Javed., M. A. Siddiqui., M. H. Khanzada., N. A. Dahar and R. Khan. 2002. Performance of sugarcane somaclones under field conditions at NIA, Tandojam. Pak. J. Bot., 34 (1): 65-71.

Naidu, N.V., V. Rajabapa Rao, V. Raja Rajeswari, M. Charumathi, Ravikumar and B., Rosiaah. 2007. 97A 85- An early maturing promising pre release sugarcane clone suitable for Andhra Pradesh. SISSTA, 1-6.

Hossain, M. A. and N. Islam. 2008. Regeneration of high sugar non-flowering somaclones of Sugarcane. Pak Sugar J. 24 (02):9-14.

Khalid, M., H. Rahman, M. A. Rabbani, Farhatullah and A. Khan. 2014. Qualitative and quantitative assessment of newly selected sugarcane varieties. Sarhad J. Agric. 30 (2):187-191.

Kent, G. A., D. J. Moller, P. D. Scroope, R. Broadfoot. 2010. The effect of whole crop processing on sugar recovery and sugar quality. Proc Aust Soc Sugar Cane Technol Vol 32:559-572.

Abo El-Hamd, A. S., M. A. Bekheet and A. F. I. Gadalla. 2013. Effect of Chemical Ripeners on Juice Quality, Yield and Yield Components of Some Sugarcane Varieties under the Conditions of Sohag Governorate. Am-Euras. J. Agric. & Environ. Sci., 13 (11): 1458-1464.

EL-Geddaway, I. H., D. G. Darwesh., A. A. El- Sherbiny., E. Eldin and A. El- Hadi. 2002. Effect of row spacing and number of buds/seed sets on growth characters of ratoon crops for some sugarcane varieties. Pak. Sugar J. (17): 7-14.

Panhwar, R. N., M. Chohan, D. B. Panhwar, M. A. Memon, Y. M. Memon and M. A. Panhwar. 2008. Relative cane yield and quality appraisal of divergent sugarcane clones in 4th cycle under Thatta climatic Conditions. Pak Sug. J. 23(01):14-19.

Keerio, H. K., R. N. Panhwar., Y. M. Memon., M. Y. Araien., M. Chohan and B. R. Qazi. 2003. Qualitative and Quantitative performances of some promising and commercial sugarcane varieties under agro-climatic conditions of Thatta. J. Applied Sciences 3(10): 670-673.

Sohu, I. A., A. M. Khaskheli, P. A. Baloch and B. A. Abro. 2008. Evaluation of yield and yield contributing parameters of different sugarcane (*Saccharum officinarum* L.) varieties under National Uniform Varietal Yield Trial. Pak. Sug. J. 23 (01):9-13.

# SUGAR INDUSTRY ABSTRACTS

## Sugar from genetically modified sugarcane: tracking transgenes, transgene products and compositional analysis

P. A. Joyce, S-Q. Dinh, E. M. Burns and M. G. O'shea
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

This study was performed to prepare the Australian sugar industry for the likely introduction of genetically modified (GM) sugarcane and derived retail sugar products, and to address some of the potential public concerns regarding the characteristics and safety of GM sugarcane products. Juice from representative stalks in a GM field trial of sugarcane plants produced using two different transformation methods (Agrobacterium-mediated or biolistics) was compared with untransformed controls [tissue culture (TC) and parent clones (PC)]. The juice was subjected to laboratory scale methods that mimic the factory crystallisation process in order to produce a crystalline raw sugar product. Molecular analysis of the raw sugar sample together with samples collected during each processing step of the laboratory crystallisation process (fibre, juice, syrup, filter mud and molasses) was conducted for the presence of transgenes (DNA) and their products (protein). This testing conclusively showed that although DNA and protein was present in GM sugarcane juice and fibre, it was absent from any samples taken from subsequent processing and crystallisation steps. The sugar compositions of juice and raw sugar produced from GM cane were indistinguishable from those of non-GM cane sourced from the same trial. This study showed that sugar crystallised from GM sugarcane plants does not contain residual DNA or proteins of the introduced transgene(s) using conventional molecular techniques. This finding will help pave the way for commercialisation of GM sugarcane and derived products.

## Comparative analysis between phenotype and bru1 marker for incidence to brown rust in sugarcane

L. Molina, J. L. Queme and F. Rosales,
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

In guatemala, the brown rust caused by Puccinia melanocephala is a majorconstraint in sugarcane (Saccharum spp.). Genetic resistance is a desired trait in new varieties. The PCR marker R12H16, developed by CIRAD, is reported to be associated with a resistance allele of the Bru1 gene. In this work, 80 sugarcane clones from our germplasm collection were genotyped with this marker, and associations were made with phenotypic data recorded in two different years and locations to identify commercial cultivars carrying Bru1. The marker was found in 26 (32.5%) out of 80 varieties and all of them showed resistance to the disease. Only 3 (5.6%) out of 54 not having the marker were phenotyped as susceptible. The comparative analysis highlights the fact that presence of the marker corresponds closely with a resistant phenotype, although its absence does not necessarily correspond to a susceptible one. It was possible to predict the inheritance pattern of the marker in some commercial varieties based on the identification of the donor parents. One third of the sugarcane area in Guatemala is grown with brown rust resistant cultivars carrying Bru1. The use of the Bru1 marker can be helpful in sugarcane breeding aiming at increasing the resistance in commercial varieties against the brown rust pathogens.

**Effects of chilling stress on protein and related gene expression in chloroplasts of sugarcane**

Yang-Rui Li, Qiao-Ling Huang, Xing Huang, Fu Sun, Bo Sun and Li-Tao Yang
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

The present study was conducted to investigate the effects of chilling stress on chloroplasts at protein and mRNA levels to provide a reference for further investigation on the molecular mechanism of chilling stress in sugarcane. Sugarcane varieties GT28 (strong cold resistant) and ROC22 (weak cold resistant) were used as plant materials, and treated under 9 d, 15 d and 24 d of chilling stress, respectively. The chloroplast protein was extracted and used for electrophoresis analysis, and expressions of the genes were analysed using real-time PCR. Electrophoresis analysis showed that, for both sugarcane varieties, the relative content of chloroplast protein decreased with increase in chilling time. The protein bands of 39.92, 32.95 and 22.87 kDa were down-regulated. Mass spectrometry revealed that they were ATP synthase subunit gamma, oxygen-evolving enhancer protein 1 and chloroplast 23kDa polypeptide of photosystem II, and they were encoded by atpC, PsbO and PsbP genes, respectively. Their fragment lengths were 937, 996 and 721 bp respectively. The obtained fragment of PsbO gene, in its complete open reading frame, has been registered in the GenBank database with the accession number JQ898540. Real-time PCR analysis showed that chilling stress suppressed the expression of atpC gene, but induced the expressions of PsbO and PsbP genes, which reached a maximum at 15 d. Generally, chilling stress promoted protein degradation, and the protein declined more in ROC22 than that in GT28. Chilling stress suppressed the expression of atpC gene, but induced the expressions of PsbO and PsbP genes in chloroplasts of sugarcane.

**The development and implementation of the BONSUCRO standards for promoting the sustainability of sugarcane products**

N. Viart and P .W. Rein
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

Pressure from the major users and traders of sugar and ethanol led to the formation of the Better Sugar Cane Initiative to develop certifiable standards for sustainable production of sugarcane. Following acceptance of the principles to be adopted, the processes involved in setting up and agreeing on a global standard are described. Over a period of about four years, a production standard, incorporating environmental, social and economic elements, and a chain of custody standards were developed and approved by the members. Now called Bonsucro, the organisation is funded almost entirely by its members, all involved directly or indirectly in the sugarcane sector, and operational and credible governance structures are in place. Certification is carried out by independent and approved certification bodies and experience to date in the certification of sugar and ethanol is described. Since it was established, the number of members of Bonsucro and the area under certified sugarcane has continued to grow steadily. The increasing acceptance of sustainability standards is being demonstrated with implications for all stakeholders. Possible limitations of a global metrics standard, challenges with respect to international recognition, and future improvements are finally discussed.

**Long shelf life of sugarcane juice obtained by tangential microfiltration**

L. Fahrasmane
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

The abundance of sugarcane in rural tropical areas and its low cost are an agro-economic opportunity for development in these areas. The manufacturing of long shelf life sugarcane juice will allow the diversification of sugarcane use. Such product could be made available anywhere at any time as beverage and/or ingredient. Many attempts have been performed in various places to produce long shelf life sugarcane juice, without success. We have succeeded in the preservation of sugarcane juice by using tangential microfiltration technology as a key stage in manufacturing of preserved cane juice (Patent EP 1 165 843 B1). The quality, the safety, and the organoleptic properties of the processed juice achieve the expectations of modern consumers and standards of soft drinks marketed in modern stores. A company, KANASAO SAS, produces KanasaoTM ( http://www.kanasao.com/ ), a long shelf life sugarcane juice, produced under licence, since 2008, in Guadeloupe F.W.I.

**Effect on sugarcane juice clarification**

M. J. Rossini Mutton, G. H. Gravatim Costa
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

The aim of this work was to evaluate the composition of clarified juice through the leaf and seed Moringa oleífera Lam. (Moringaceae) extract use in contrast to using synthetic polyelectrolytes. The experiment was carried out at FCAV/UNESP campus Jaboticabal, SP, Brazil using juice from the cane variety RB867515. After the juice was extracted, the clarification process was done by defecation. The experimental design was the completely randomised with four treatments (extracted juice, clarified juice using the seed extract, leaf extract, and a conventional synthetic polyelectrolyte). The treated juice was analysed for brix, colour, phenolic compounds, starch, proteins, and amino acids. Results were submitted to the analysis of variance F-test and the averages obtained were analysed by the Tukey test (5%). The seed extract promoted higher reduction in the colour content in the clarified juice. The juice clarification reduced significantly the starch and protein contents, without significant differences between the clarification additives. The leaves extract was the only treatment that removed the phenolic compounds from the juice. The leaves and seeds M. oleífera extracts had an equivalent or superior behaviour than the evaluated synthetic polyelectrolyte.

**Use of 'Big Mill' tests in evaluating and promoting new varieties: case example of a Parry India variety**

S Rajeswari, P Bharathi and Manjunatha S Rao
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

E.I.D. Parry is a major sugar milling company in India and has established a world class R&D centre to develop varieties suited to areas supplying its mills. The aim is to provide for higher economic returns to farmers and achieve higher recovery of sucrose in mills. A breeding programme with a 10-year selection system was initiated in Bengaluru where crossing among both elite sugarcane cultivars and using wild canes is carried out. Each year more than 25,000 seedlings are planted at two selection locations. The selected clones are tested both in-house and through the 'All India Coordinated Research Project' in association with other institutes. The variety PI 07131 was identified through this program and performed exceedingly well across 15

locations in small-plot trials. In pooled data across plant and ratoon crops, PI 07131 recorded a cane yield and sugar yield 6% and 2%, respectively, better than the comparator check commercial cultivars. PI 07131 is also resistant to red rot and smut. Large-scale demonstrations were conducted to multiply this variety and scale-up the evaluation area. More than 1000 big mill tests (BMTs) were conducted and PI 07131 was found to have 0.2-0.4% higher pure obtainable cane sugar (POCS %) when compared to Co 86032, the major existing cultivar. BMTs provided an accurate assessment of POCS of the new variety, which is a critical factor affecting profitability of the sugar mills. The high yielding, high sugar-recovery, and free-trashing characteristics of PI 07131 motivated adoption of the variety by farmers in Parry mills. It is now well accepted as a leading variety, covering 40% of the area in Nellikuppam (5085 ha – April 2014 to March 2015) with a yield 5-10 t/ha greater than alternative cultivars. This results in economic gains of USD 130-260 per ha to farmers. Other clones are in the pipeline and expected to be released in coming years. The use of BMTs, as illustrated through the example of PI 07131, is advocated as a way to help evaluate and promote adoption of new varieties.

**Farmer Acceptance Selection – a participatory approach to selection and technology transfer for new sugarcane varieties**

Manjunatha S Rao, S Rajeswari, MKC Varatharaj and A Lourdusamy
Proc. Int. Soc. Sugar Cane Technol., Vol. 28, 2013

Significant progress has been made in developing commercial sugarcane cultivars that possess high yield, high sugar and disease resistance. Although many varieties are developed, commercialization of new varieties may be slow due to poor acceptance by growers in specific regions. E.I.D. Parry has introduced a new concept of farmer acceptance selection after six stages of systematic varietal selection and evaluation programme. Eight promising varieties, viz., PI 05-0535, PI 05-0807, Co 06022, PI 03-1240, PI 03-0433, PI 01-0328, PI 01-2752, 2003 V 46, were planted along with standard varieties already under cultivation, viz., Co 86032, PI 00-1110, PI 00-1401 and PI 00-0966. Field traits, including germination, stalk population, stalk length, stalk thickness, suckering, spines, trashing and lodging, were recorded. The crop was evaluated by the farmers at different stages of cane growth especially early, and at 7 months, 9 months and at harvest using a formatted questionnaire. Simultaneously, these varieties were evaluated for the cane yield at harvest and quality parameters at 10, 11 and 12 months. Based on the field data and farmers' feedback, the varieties PI 05-0535, PI 05-0807, Co 06022 and 2003 V 46 were selected. Inputs from the farmers were crucial for their acceptance. They were given to selected lead farmers for multiplication. This concept was introduced in one of the Parry mills in Tamil Nadu and farmers from EID group mills observed the crop. The merits and weaknesses of different varieties were explained to farmers in detail. The farmers' observations were very useful in selecting new varieties. Through this concept, new varieties were successfully promoted in farmers' fields and the acceptance level was high in varietal multiplication. This is a participatory approach to commercializing new varieties. Through involvement by the farming community in selection, we believe the adoption of these varieties to replace the existing ones was smoother.

# INTERNATIONAL EVENTS CALENDAR

## 2017 MEETINGS AND CONFERENCES

**June 14-16:** ASSCT, Joint Division Meeting, Crowne Hotel, New Orleans, LA USA, ASSCT.org

**June 26-30:** XIV International Congress on Sugar and Sugarcane Derivatives / Diversification, PABExpo Exhibition Center, Havana, Cuba diver2017@icidca.azcuba.cu

**August 3–5:** 75th Annual Convention of The Sugar Technologists Association of India, Hotel Le Meridien, Kochi, Kerala, India www.staionline.org

**August 4–9:** 34th International Sweetener Symposium, Omni San Diego Hotel, San Diego, CA USA, Sugaralliance.org

**August 14-18:** Philsutech Annual Convention, Cebu City, The Philippines, philsutech.weeby.com

**August 15–17:** 90th SASTA Congress, at ICC, Durban, South Africa Sasta@sugar.org.za

**August 22–25:** Fenasucro & Agroncana, Centro Eventos, Zanini, Sertaozinho – SP, Brazil, Fenasucro.com.br

**September 15:** ASSCT, Florida Division, UF/IFAS Everglades Research & Education Center, Belle Glade FL. USA, ASSCT.org

## 2018 MEETINGS AND CONFERENCES

**March 25-28:** 77th Sugar Industry Technologist Conference, Naples, Florida, USA Sucrose.com

**June 5-8:** IIRB Congress (International Institute for Beet Research), Deauville, France IIRB.org

**June 25-27: `** ASSCT, Joint Division Meeting, Hyatt Regency Coconut Point, Bonita Springs, FL, USA, ASSCT.org

**August 3–8:** 35th International Sweetener Symposium, The Grand Traverse Resort, Traverse City MI USA, Sugaralliance.org

## 2019 MEETINGS AND CONFERENCES

**May 5-8:** 78th Sugar Industry Technologist Conference, Durban, South Africa Sucrose.com

**August 2–7:** 36th International Sweetener Symposium, The Omni Grove Park Inn, Ashville, NC USA, Sugaralliance.org

# STORY OF SWEETS

**i. Banana Cream Pie**

***Ingredients***

Crust:
5 ounces gluten-free arrowroot cookies (about 50 cookies)
2 tablespoons sugar
1/4 cup unsalted butter, melted
Cooking spray
Filling:
1/2 cup sugar
3 1/2 tablespoons cornstarch
1/8 teaspoon salt
2 1/2 cups 1% low-fat milk
3 large egg yolks
1 teaspoon vanilla extract
1/2 teaspoon banana extract
2 tablespoons unsalted butter
3 ripe bananas, peeled and cut into 1/4-inch slices
1 1/2 cups frozen fat-free whipped topping, thawed
1 tablespoon almond brickle chips (such as Heath)

**Directions**

Arrange half of banana slices in a single layer over crust; top with half of filling mixture. Repeat layers. Cover surface of filling with plastic wrap coated with cooking spray. Chill at least 3 hours. Uncover, and spread whipped topping over filling. Sprinkle with brickle chips.

**ii. Sweet Potato Balls**

***Ingredients***

calories 237
fat 9.6 g
satfat 5 g
monofat 2.3 g
polyfat 0.5 g
protein 3.7 g
carbohydrate 37 g
fiber 1.6 g
cholesterol 68 mg

**Directions**

Preheat oven to 350°.
To prepare crust, place cookies and 2 tablespoons sugar in a food processor; process until finely ground. Add 1/4 cup melted butter; process until blended and moist. Press into bottom and up sides of a 9-inch pie plate coated with cooking spray. Bake at 350° for 8 to 10 minutes or until lightly browned. Cool completely on a wire rack.
To prepare filling, combine 1/2 cup sugar, cornstarch, and salt in a heavy saucepan over medium heat, stirring to combine. Add milk and egg yolks, stirring with a whisk. Cook 6 minutes or until mixture starts to boil and begins to thicken, stirring occasionally. Remove from heat. Stir in extracts and 2 tablespoons butter. Place pan in a bowl of ice to cool.

# GUIDELINES FOR AUTHORS

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