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DEXTRANASE FOR PROCESS EFFICIENCY IMPROVEMENT: THE THAI EXPERIENCE

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ABSTRACT

Sugarcane production in Thailand for the last milling season (2011–12) was around 98 million tonnes. Most of the cane had to be burnt before harvesting due to a shortage of manpower. The cut-to-crush time lasted more than 48 hours which resulted in the proliferation of micro-organisms, particularly *Leuconostoc mesenteroides*. The dextran product of the micro-organisms accumulated in the process and caused a lot of problems during the last milling period. Trials using dextranase were conducted at two sugar factories with capacities of 15 000 and 20 000 tonnes cane per day. The average concentrations of dextran in raw syrup and final molasses during observation were found to be around 1600 ppm and 2500 ppm, respectively. The enzyme was applied in the range of 2 to 5 ppm to the syrup before entering the last evaporator where the temperature was 65 to 70°C. The concentration of dextran in the final molasses was found to be 81% lower compared with no addition of enzyme. The recovery calculated as sugar of 96 pol was found to cover the enzyme cost during treatment.

Key Words: Dextranase, Dextran, Polysaccharides, Leuconostoc Mesenteroides.

INTRODUCTION

Thailand is one of the world's biggest exporters of cane sugar. Sugarcane cultivation in Thailand for the year 2011–2012 was around 98 million tonnes. The shortage of labour for harvesting the sugarcane was the main reason why the cane was burnt before harvesting. About 80% of the trash including straw, tops and green and dry leaves are removed in the burning process. These components constitute about 25% of the entire sugarcane stalk. In Thailand over 50% of the cane is burnt. Moreover, the cut-to-crush delay is usually more than 48 hours. This results in the proliferation of many micro-organisms, particularly *Leuconostoc mesenteroides,* the lactic acid bacterium which mainly attacks the sucrose in the cane and produces dextran.

Dextran is a high molecular weight polysaccharide comprising at least 50% of α-1,6 linked glucose units and may contain other branch linkages such as α-1,2 or 1,4. The straight chain consists of α-1,6 glycosidic linkages between glucose molecules, while branches begin from α-1,3 linkages. Dextran is synthesised from sucrose by certain lactic acid bacteria, the best known being *Leuconostoc mesenteroides* and *Streptococcus mutans*. The presence of dextran immediately indicates sugar loss with consequences to economic losses for the sugar industry. It is estimated that every one part per million (ppm) units of dextran in sugar juice results in a loss of 0.0011 kg of raw sugar produced per tonne of sugarcane (Day, 1994).

The name dextran refers to a large family of glucose polymers whose structures and subsequent properties can vary widely. This variation in structure poses a huge challenge for any analyst trying to detect the molecules especially against a substantial background of saccharides with similar structures and properties (Singleton *et al*., 2002).

Dextran detection has been dominated by two techniques, namely the haze and the Roberts tests (Keniry *et al*., 1969; Roberts, 1983, respectively). Both tests exploit the dextran's tendency to precipitate out of solution in alcohol. These current industry standards for dextran quantification have long been proved unreliable and inaccurate as well as non-specific, costly and time consuming (Kubik *et al*., 1994; De Stefano and Irey, 1986; Curtin and McCowage, 1986; Brown and Inkerman, 1992).

Many alternative tests have been proposed and investigated, often as modifications on the theme of alcohol precipitation with various chemical and/or enzymatic inclusions. There is a long- lasting need for a fast, accurate, simple and inexpensive method for the detection and quantification of dextran. Enzyme-linked immunosorbent assay (ELISA) is one of the newest methods for dextran detection which has high accuracy, reliability and is less time consuming (Vanichsriratana *et al*.,2013). Dextran contamination is widely known for its deleterious effect on the sugar industry.

Therefore, physical methods such as ultrafiltration, dialysis and reverse osmosis are very useful for removing dextran, but they are not yet technologically developed for their economical application in the sugarcane processes. The only appropriate method in the sugar industry is the enzymatic hydrolysis of dextran. Dextranase (EC 3.2.1.11(**α**-D-1,6 glucan-6-glucano hydrolase)) is the enzyme that hydrolyses the α -1,6 linkages mainly present in the dextran structure and is frequently used in the sugar factory to remove dextran from juice where contamination exists. The aim of this study was the application of dextranase enzyme to reduce dextran content in sugar mill process streams and to demonstrate the effective level of enzyme.

MATERIALS AND METHODS

Dextranase L 'Amano' was obtained from Amano Enzyme Inc., Japan. It has an activity of 30 000 U/mL and pH in the range of 6–8.5 where one unit of dextranase activity is defined as the amount of enzyme producing 1 micromole of reducing sugar per minute at 37°C and pH 6.0. The samples for dex tran determination were collected from the Thai sugar factories A and B. A dextran ELISA Kit was purchased from Lifespan Technologies, USA. Standard dextran solutions were obtained from Sigma-Aldrich, Singapore (M.W. 200,000).

Determination of dextran contamination in sugar factories

The experiment was conducted at sugar factories A and B. The percentage of burnt sugarcane milled was 84 and 65, respectively. Duplicate daily composite samples were taken from mixed juice, clarified juice, raw syrup and final molasses for the period of 14 days. Dextran determination was undertaken by using the dextran ELISA Kit. Standard dextran solutions were prepared by dilution of dextran to concentrations of 3, 10, 30, 100, 300, 1000 and 3000 µg/mL. The change of colour was detected at 450 nm by an absorbance microplate reader.

The concentration of dextran was measured through the colour formation of antibody-bound peroxidase in the sample wells which is proportional to the dextran concentration in the sample and developed using tetramethylbenzidene (TMB) substrate. The standard curve had a coefficient of determination (R^2) in the range of 0.98–0.99 (Vanichsriratana *et al*., 2013).

Application of dextranase

The concentrations of dextranase at 2 and 5 mg/kg cane were applied to the last effect of the evaporator set which was operating at a temperature of 65–70°C. The dextran content was analysed in the raw syrup and final molasses during periods with and without enzyme application to allow a comparison to determine the effectiveness of the dextranase application.

Determination of sugar recovery and purity of final molasses

The crystal content, purity rise in C-molasses and purity of final molasses of both factories during the investigation were observed. The sugar production was calculated to 96 pol basis per tonne sugarcane at 10% commercial cane sugar (CCS). The comparison during the treatment of enzyme and before adding was conducted to determine the recovery.

Determination of brix, pol and purity of sugar products

The pol of the syrup and molasses samples was determined by ICUMSA method GS1/2/3/9-1 (2007) and GS5/7-1 (1994), respectively. The brix of the samples was determined using ICUMSA method GS4/3-13 (2007).

RESULTS AND DISCUSSION

Examination of dextran concentration

The concentration of dextran in mixed juice, clarified juice, raw syrup and final molasses from factories A and B is shown in Figure 1. Factory A showed higher dextran content than factory B reflecting the higher percentage of deteriorated burnt sugarcane being processed. The cut-to-crush delay at Factory A was, on average, 4–6 hours longer than for Factory B. The level of exposure of the internal tissues of sugarcane increases with burning and inhibits the activity of phenol oxidase enzymes which display the antibacterial activity in the plant (Jiménez, 2005).

Application of dextranase

Dextranase was used before the end of the milling season in the amount of 2–5 ppm on cane at each factory. The enzyme was introduced to the last effect of the juice evaporator set with the operating temperature and pH around 65–70°C and pH of 6.8–7, respectively.

The result from factory A is shown in Table 1. The average dextran concentration in the syrup at 60 brix before and after the utilisation of enzyme was 1492 and 241 ppm, respectively. Likewise, the average dextran concentration before and after adding the enzyme in final molasses was 4360 and 818 ppm.

The reduction in dextran concentration illustrates that the addition of dextranase to the final effect is a viable and effective option for the degradation of dextran. Furthermore, there appeared to be no significant benefit in the average content of dextran in final molasses during the period when 5 ppm dextranase was added. Similarly, factory B showed the same trend when applying dextranase enzyme (data not shown). It was thought that 1 ppm might not be sufficient to reduce the dextran concentration in any of the sugar process streams. The addition temperature of 65–70°C and concentration conditions of the final effect appeared not to limit the ability of the dextranase to degrade the dextran.

Sugar recovery yield and final molasses purity

It was found that there was a marginal improvement in sugar recovery from factory A (weight of sugar at 96 pol/tonne cane at 10 CCS) after the use of enzyme as exhibited in Figure 2. The sugar yields before and after the application of dextranase were 82.5 kg/tonne cane and 84 kg/tonne cane, respectively.

For factory B, there was no obvious increment of sugar yield (Figure 3) but the factory was satisfied that the sugar yield did not change. From previous experience, the sugar yield always decreased during the final stages of the milling season. Furthermore, the crystal content of C massecuite and purity rise in the C molasses of both factories were not significantly different (36–38% crystal contents and 1.0–1.1 for purity rise).

CONCLUSION

According to the results from Thai sugar factories A and B presented in this study, it was apparent that dextran formation associated with the processing of a high proportion of burnt sugarcane and long delay times before milling remains a cane quality issue for the industry. Dextranase is an effective and practical way to reduce the dextran contamination in the milling processes. The enzyme showed thermal tolerance when used in the last effect of the evaporator set operating at 65–70°C. The addition of dextranase at a concentration of 2 ppm on cane was sufficient to reduce the dextran in final molasses by around 81%. The utilisation of dextranase enzyme at 2 ppm could assist to increase the sugar yield by 1.5 kg/tonne cane. The limited trials at factory A indicated that the crystal content of C massecuite and the purity rise in C molasses could be maintained at typical levels (approximately 38% and 1.1 purity units) when dextranase is added to reduce the dextran level.

Table-1 Dextran content in raw syrup and final molasses from factory A, before and after adding dextranase enzyme

Date	Dextranase concentration (mg/kg cane)	Dextran content (ppm)*	
		Raw syrup	Final molasses
18.04.12	0 ppm	1520	4765
19.04.12	0 ppm	1671	3825
20.04.12	0 ppm	1496	4392
21.04.12	0 ppm	1331	5629
22.04.12	0 ppm	1440	3919
23.04.12	0 ppm	867	3629
25.04.12	2 ppm	165	542
26.04.12	2 ppm	251	815
27.04.12	2 ppm	187	613
29.04.12	2 ppm	138	393
01.05.12	2 ppm	152	395
03.05.12	5 ppm	212	600
05.05.12	5 ppm	251	497
07.05.12	5 ppm	235	1478
09.05.12	5 ppm	320	1199
11.05.12	5 ppm	497	1644

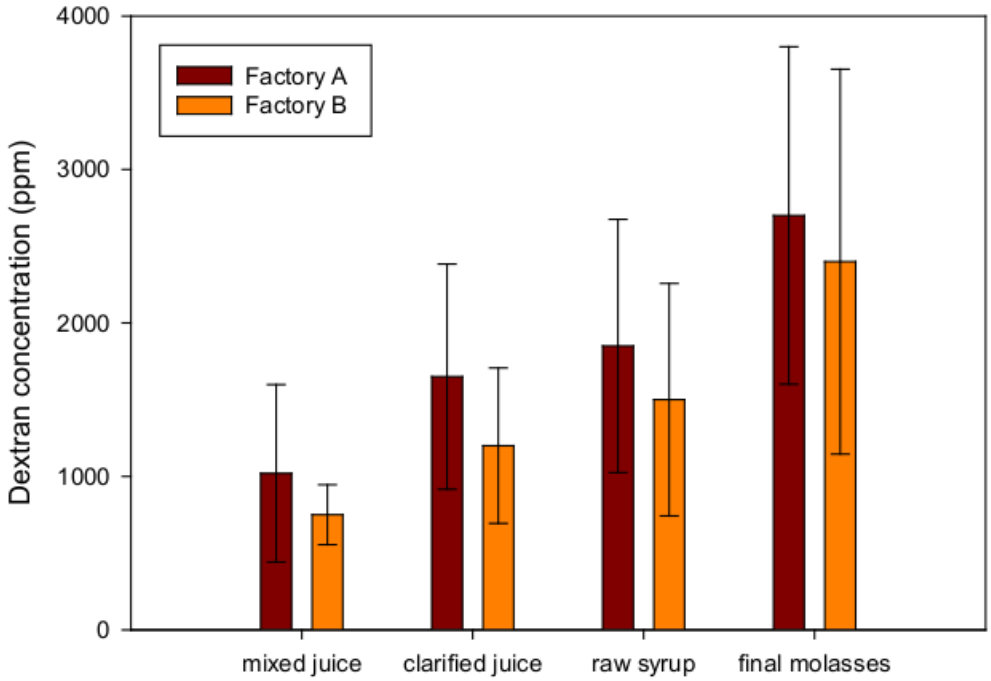

Fig. 1—Dextran concentration at factories A and B before the application of dextranase.

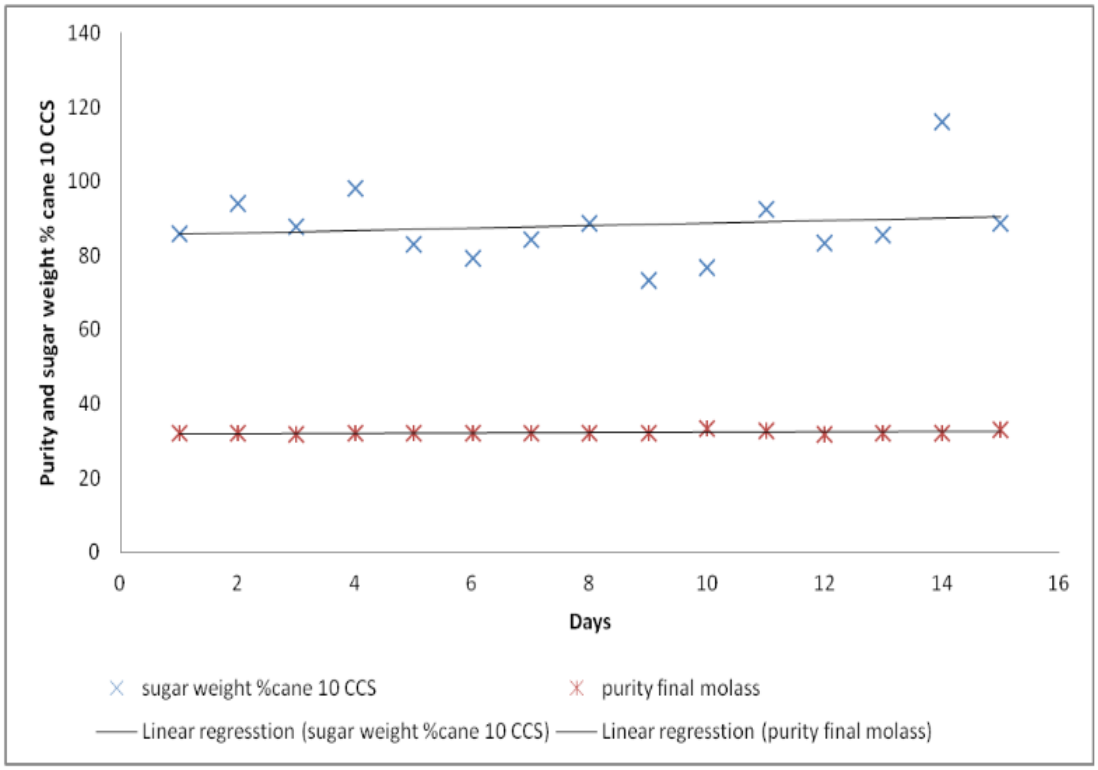

Fig. 2—Purity and sugar yield % cane at 10 CCS for factory A.

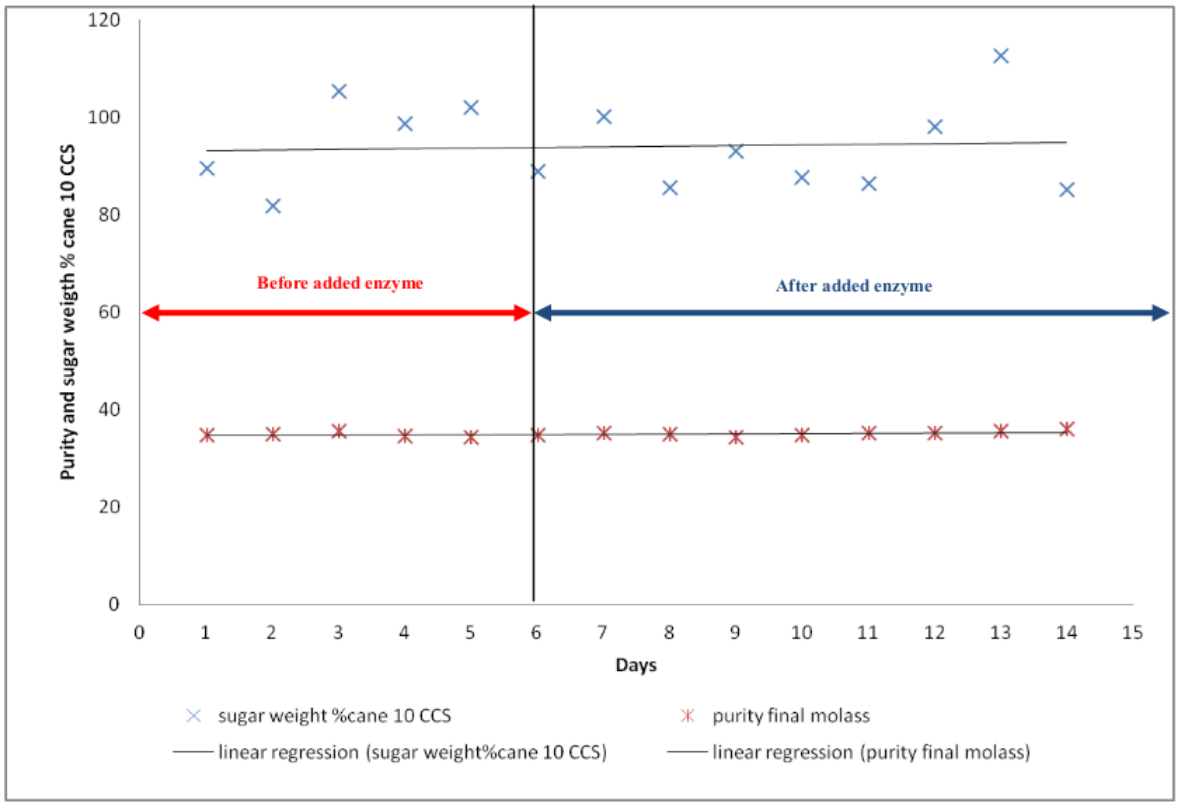

Fig. 3—Purity and sugar weight % cane 10 CCS for factory B.

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BIOMETRIC EFFICIENCY OF SUGARCANE PROMISING AND COMMERCIAL CLONES AT DIFFERENT LOCALITIES IN CENTRAL PUNJAB

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ABSTRACT

Eight sugarcanes promising and commercial clones were evaluated at Sugarcane Research Institute, Faisalabad. These clones were tested for their performance at three locations during February- March 2016-17 in Central Punjab viz Nawan Lahore, Tandlianwala and Shorkot. The trials were conducted at farmer's field using RCBD with three replications. The data on germination%, tillers/plant, no. of millable canes, cane yield t/ha and CCS % were recorded during the course of study. The sugarcane clone S2006-US-658 gave the 17.9% higher cane yield as compared to the check variety CPF-249. As far as CCS % is concerned, clone S2003-US-633 gave the highest sugar recovery that is 4.3% more than check variety whereas S2006-US-658 has the lowest CCS % i.e. 0.7 % less than the check variety.

INTRODUCTION

Sugarcane is the 2nd major cash crop of the Pakistan, where it is grown on commercial scales in three provinces i.e. Punjab, Sindh and Khyber Pakhtunkhwa (Wikipedia, 2016). The cane and sugar yield obtained in our country is still less than that of other developed cane growing countries of the world.

This is mainly due to unavailability of new sugarcane varieties having high cane yield and sugar potential. The average sugarcane yield of Punjab is 64.07 t/ha, which is higher than the national average cane yield i.e. 54.34 ton/ha during the year 2016-17. Fortunately, average cane yield of sugarcane and sugar recovery of Pakistan is at par with the world average. The sugar recovery of Pakistan was around 9.97 percent. The most feasible option is to plant new sugarcane varieties that are capable of producing sugar and other products of economic importance at lower cost than the existing commercial varieties to enhance crop productivity and sugar recovery in the country.

MATERIALS AND METHODS

The study was comprised of eight sugarcanes promising and commercial clones viz; S2003-US-127, S2003-US-633, S2006-US-658, S-2008-FD-19, CPF-246, CPF-247, CPF-248, and CPF-249 at three different locations during February-March 2016-17 in Central Punjab. The details of locations with varieties are as under:

Locations	Varieties
Chak No. 165/J.B Nawan Lahore	S2003-US-127, S2003-US-633, S2006-US-658, S2008-FD-19, CPF-246, CPF-247, CPF-248, and CPF-249
Chak No.596/G.B Tandlianwala	S2003-US-127, S2003-US-633, S2006-US-658, S2008-FD-19, CPF-246, CPF-247, CPF-248, and CPF-249
Mauza Yarewala Shorkot	S2003-US-127, S2003-US-633, S2006-US-658, S2008-FD-19, CPF-246, CPF-247, CPF-248, and CPF-249

Experiment was laid out in RCBD with three replications on an area of half acre. Data on germination %, tillers/plant, no. of millable canes/ha, cane yield tons/ha and CCS% was recorded using the standard procedure. The data was analyzed by MSTATC programme and difference of means were compared with LSD test (Steel and Torrie 1990).

RESULTS AND DISCUSSION

Chak No.165/J.B Nawan Lahore

The Table-1 revealed that the clone S2006-US-658 gave the significally maximum cane yield i.e. 148 tons/ha at this location. Higher yield produced by this clone seems to be due to significantly more no. of millable canes/ha. Commercial & promising clones CPF-249, CPF-246, S2008-FD-19, S2003-US-127, CPF-247 and S2003-US-633 produced less cane yield than S2006-US-658, however, others are statistically at par with one another. The lowest cane yield (102 t/ha) was produced by CPF-248. The highest CCS% 12.8, 12.7 and 12.7% was produced by S2003-US-633, S2003-US-127, and CPF-246 respectively. Sarwar *et al*., (2016) has reported that varieties behaved differently with estimation to millable canes, cane yield and CCS%. The results are in conformation to the present findings.

Chak No. 596/G. B Tandlianwala

The perusal of the data in Table-2 indicated that significantly maximum tillers/ plant (1.9) was produced by S2003-US-127 which was statistically at par with S2008-FD-19, S2003-US-633, CPF-247 and CPF-246. The clone S2003-US-633 produced statistically significant millable canes/ha while the variety CPF-248 gave the lowest millable canes/ha. The clone S2008-FD-19 exhibited higher cane yield which was followed by S2006-US-658 and S2003-US-633 while the variety CPF-248 gave the lowest yield (56 t/ha). The CCS% of S2003-US-633 is the maximum (12.6) among the clones but S2003-US-658 gave the lowest (10.4). The findings of Sarwar *et al* (2016) are in agreement with these findings.

Mauza Yarewala, Shorkot

It is obvious from the data in Table-3 that the varieties/clones CPF-246, CPF-247, S2008-FD-19 and S2006-US-658 gave statistically different germination% and varieties CPF-248 and CPF-249 showed the lowest. The variety CPF-249 produced the statistically maximum tillers/plant (2.31) and millable canes (000)/ha (193). The varieties CPF-246 and CPF-247 produced statistically lower tillers/plant (1.63, 1.71) and no. of millable canes (000)/ha (135, 138). The clone S2006-US-658 gave the higher cane yield (156) tons/ha while the CPF-246 produced the lowest cane yield (96) tons/ha. Afghan *et al* (2013) have reported that no. of millable canes positively correlated with cane yield. The CCS% of all varieties are statistically at par except S2006-US-658 which gave the lowest sugar contents.

CONCLUSION

- It was shown in graph that the sugarcane variety S2006-US-658 gave 17.9% increased cane yield tonnes/ha over the control variety CPF-249. Similarly, the sugarcane clone S2008-FD-19 and S2003-US-127 produced the 5.2% and 3.1% increased cane yield tonnes/ha over the check sugarcane variety.
- The sugarcane clones S2003-US-633 gave 1.9% decrease in yield ton/ha over the check variety.
- As far as, the CCS% is concerned the sugarcane clones S2003-US-633, S2003-US-127 and S2008-FD-19 gave the 4.3, 2.9 and 0.9% respectively more CSS% over the check variety. While the sugarcane clone S2006-US-658 gave 0.7% less CCS% over the check variety.

Table-1 Chak No. 165/Gandewala, Nia Lahore

Sr. No.	Varieties / clones	Germination%	Tillers / plant	Millable canes/ha (000)	Yield (t/ha)	CCS %
1	S2008-FD-19	59.8 b	2.19 a	179 a	120 bc	11.99 ab
2	**S2006-US-658**	**57.2 bc**	**1.69 b**	**177 ab**	**148 a**	**10.8 c**
3	S2003-US-633	76.5 a	1.43 c	158 cde	113 bc	12.8 a
4	S2003-US-127	54.6 cde	1.44 c	159 bcd	125 b	12.7 a
5	CPF249	53.8 de	1.75 b	172 abc	127 b	11.4 bc
6	CPF 248	56.6 bcd	1.38 c	147 de	102 c	11.6 bc
7	CPF 247	52.5 e	2.10 a	186 a	115 bc	11.3 bc
8	CPF 246	75.3 a	1.36 c	110 e	120 bc	12.7 a
LSDat0.05		**3.29**	**0.238**	**18.23**	**19.56**	**0.98**

Table-2 Chak no. 596/GB, Tandlianwala

Sr. No.	Varieties / clones	Germination %	Tillers / plant	Millable Canes / ha	Yield (t/ha)	CCS %
1	**S2008-FD-19**	**40.2 de**	**1.6 ab**	**200 b**	**168 a**	**11.1 bc**
2	S2006-US-658	41.1 de	1.2 bc	158 d	163 ab	10.4 c
3	S2003-US-633	52.7 ab	1.5 ab	226 a	158 ab	12.6 abc
4	S2003-US-127	37.8 e	1.9 a	181 bc	142 c	11.1 bc
5	CPF249	45.2 cd	1.1 bc	195 b	140 c	11.9 abc
6	CPF 248	50.8 bc	0.7 c	90 e	56 f	11.8 abc
7	CPF 247	50.4 bc	1.6 ab	191 b	147 bc	10.9 c
8	CPF 246	58.6 a	1.4 ab	168 cd	140 c	11.5 abc
LSD at 0.05		**6.29**	**0.69**	**18.61**	**16.49**	**1.41**

Table-3 Moaza Yarewala, Basti Mangna, Shorkot

Sr. No.	Varieties / clones	Germination %	Tillers / plant	Millable Canes/ha (000)	Yield (t/ha)	CCS %
1	S2008-FD-19	55.6 a	1.92 ab	158 b	128 bc	11.9 ab
2	**S2006-US-658**	**53.2 a**	**1.72 b**	**155 bc**	**156 a**	**10.5 c**
3	S2003-US-633	49.3 ab	1.85 ab	157 b	117 c	12.5 a
4	S2003-US-127	52.3 ab	2.04 ab	162 b	139 ab	12.1 a
5	CPF-249	43.9 b	2.31 a	193 a	128 bc	11.7 b
6	CPF 248	44.1 b	1.73 ab	140 cd	115 cd	12.5 a
7	CPF 247	55.9 a	1.71 b	138 d	119 bc	12.4 a
8	CPF 246	56.5 a	1.63 b	135 d	96 d	12.3 ab
LSD at 0.05		**9.0**	**0.59**	**15.79**	**19.90**	**0.97**

Summary Table Pooled means of 3 Locations for 5 clones during 2016-17

Sr. No.	Variety	Increased Yield %	Increased CCS %
1	S2008-FD-19	5.2	0.9
2	S2006-US-658	17.9	-0.7
3	S2003-US-633	-1.9	4.3
4	S2003-US-127	3.1	2.9
5	CPF-249	0.0	0.0

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EVALUATION OF DIFFERENT SUGARCANE GENOTYPES UNDER AGRO-CLIMATIC CONDITION OF FAISALABAD

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ABSTRACT

A research experiment was conducted at research area of Sugarcane Research Institute, Faisalabad to evaluate the performance of forty seven sugarcane clones against two standard varieties HSF-240 and CPF-247 for different agronomic traits and yield characters during the crop season 2014-15 at preliminary yield trial. The results revealed that 15 clones out of 47 (32%) were selected. In set-I, , 6 out of 14 clones , in set-II, 4 out of 14 clones, in set-III, 4 out of 14 clones, in set-IV, 1 out of 5 clones were selected and promoted to semi-final trial for further study on the basis of good performance. In set-1, Clone S2012-SL-424 gave higher cane yield (73.83 t ha^{-1}) with sugar yield of 9.86 t ha^{-1}. In set-II, the clone S2012-M-799 gave higher cane yield of 86.67 t ha^{-1} with 11.61 t ha^{-1} sugar yield. In set-III, the clone S2012-M-1046 gave higher cane yield (97.63 t ha^{-1}) with 12.64 t ha^{-1} sugar yield. In set-IV, the clone S2011-FD-18 gave higher cane yield of t ha^{-1} with t ha^{-1} sugar yield. The remaining 32 clones (68%) out of 47 were rejected due to diseases susceptibility, lodging, pith and poor growth performance.

Key words: Sugarcane clone, nursery, standard variety, disease, pithiness

INTRODUCTION

Agriculture is the life line of Pakistan's economy. It accounts for 19.5 percent of the gross domestic product, employes 42.3 percent of the labour force and provides raw material for several value-added sectors. About 70% population is directly or indirectly related with agriculture. It thus plays a central role in national development, food security and poverty reduction. During 2016-17, the agriculture sector achieved growth of 3.46 percent (Anonymous, 2017).

Sugarcane is the main sugar-producing crop (Junejo *et al.,* 2010). It occupies an important position in national economy in order to drive the large sugar industry. Its share in value added in agriculture and GDP is 3.4 and 0.7 percent respectively. During 2016-17, sugarcane production was 73.6 million tones, showing an increase of 12.4 percent against 4.23 percent last year (Anonymous, 2017).

Sugarcane is cultivated in many of the world countries with Brazil as a major producer followed by India, China, Pakistan, Thailand and Mexico (FAO., 2010). It provides employment and by products for industrial sector. The sugar industry is second to textile in Pakistan which is primarily based on the mercy of sugarcane cultivation (Bahadar *et al., 2002*). It is also an important cash crop of Pakistan (Ahmad *et al.,* 1991), which plays an important role in economic uplift of farmers. In Pakistan about 99% of the sugar is extracted from sugarcane to meet the demand at domestic level (Azam and Mukarram, 2010).

The average per hectare yield in Pakistan is less than other cane growing countries of the world (Sohu, *et al.,* 2008). One and major reason for that, is our farmers do not have option regarding high yielding varieties (Majeedano, *et al.,* 2004). The cane and sugar yield of sugarcane crop can be improved with high yielding varieties and improved production technology (Heinz, 1987).

Sugarcane crop improvement in many countries relies on conventional breeding, mutation breeding, somaclonal variation and genetic engineering (Dalvi *et al.,* 2012*;* Rajeswari *et al*., 2009).

Sugarcane improvement through conventional methods is dependent on the nature of flowering, viability of pollen, seed (Moore & Nuss, 1987; Khan *et al.,* 2008) and the genomic complexity of sugarcane crop (Ingelbrecht *et al*., 1999). Sugarcane having complex genome, low fertility and large genotype x environment interactions make traditional varietal improvement and genetic studies difficult and laborious (Mendoza, 2000).

In Pakistan, the flowering and seed set under natural conditions is a very serious problem in sugarcane that hampers varietal improvement. In Pakistan the basic facilities for hybrid seed production and variety development are lacking. Though the coastal belt in Sindh, is endowed with specific climatic conditions where sugarcane plants flower. But at local spots where plants flower, non synchronization in genotypes for cane flowering reduces the possibility of hybridization (Tiawari *et al.,* 2009).

Therefore, sugarcane variety development in Pakistan is mainly based on import of germplasm from the cane breeding stations abroad and also through exotic or locally collected fuzz (Kaloi *et al.*, 2007). In most of the cane breeding programs large numbers of seedlings are grown from fuzz (true seed), selections are made in subsequent generations to obtain superior clones/ genotypes for release as new varieties.

The development of new sugarcane varieties is not possible in Pakistan because of intricate flowering of the plant and non availability of sugarcane breeding facility and acclimatization (Javid *et al.,* 2001). Thus the selection is the base line to cane agronomist in Pakistan to develop new varieties.

Potential of new genotypes needs to be tested in local environment before deciding to release as a new cultivar in a particular region (Khan *et al.,* 2000). All the stages in varietal selection programme are important but establishment of a good nursery is of prime importance. Keeping in view the importance of nursery, the present study was conducted for the evaluation of qualitative and quantitative characteristics of sugarcane genotypes under the agro climatic condition of Faisalabad.

MATERIALS AND METHODS

The study was conducted at Sugarcane Research Institute, Faisalabad during crop season 2014-15. Four sets of preliminary varietal yield trial consisting of 47 Sugarcane clones and two check varieties HSF-240 and CPF-247 were laid out in RCBD in three replications. Experiments were sown on 27-10-2014 with net plot size of 4 m x 3.6 m by keeping inter-row spacing of 120 cm.

All the agronomic and cultural practices were applied as and when considered necessary during the course of study. The data of different yield parameters (number of canes per hectare, brix percentage and cane yield in tons per hectare) were determined at harvest while germination and tillering data were recorded at 45 and 90 days after sowing.

The brix reading was recorded by hand refractometer. The data was statistically analyzed as mentioned by Steel and Torrie (1984) at probability 5% to compare their means. After comparing the qualitative and quantitative characters of all clones with standard variety, fifteen clones were selected and promoted to semi final stage for further study in variety development programme of sugarcane, while remaining thirty two clones were rejected due to undesirable characters.

RESULTS AND DISCUSSION

These results are summarized in table 1, 2, 3, 4. In set-I, 14 clones along with two standard varieties HSF-240 and CPF-247 were studied, out of which 6 clones i.e. S2012-SL-280, S2012-SL-424 S2012-SL-426, S2012-SL-443, S2012-M-622 and S2012-M-632 were

selected and promoted to semi final varietal for further study on the basis of good performance.

Clones S2012-SL-424 gave higher cane yield 73.83 t ha^{-1} with sugar yield of 9.86 t ha^{-1} which was followed by S2012-SL-443 with 72.92 t ha^{-1} cane yield and 9.98 t ha^{-1} sugar yields respectively. The others 8 clones were rejected due to smut, red rot, pith and poor growth performance. In set-II, 14 entries alongwith two standard varieties HSF-240 and CPF-247 were studied.

Out of which 4 clones i.e. S2012 M-780, S2012-M-791, S2012-M-799 and S2012-SL-883 were selected and promoted to semi final varietal trial on the basis of good performance. The clones S2012-M-799 gave higher cane yield of 86.67 t ha^{-1} with 11.61 t ha^{-1} sugar yield which was followed by S2012-M-791 and S2012-M-780 having cane yield of 73.35 and 72.48 t ha^{-1} with 9.19 and 9.66 t ha^{-1} sugar yield respectively. The remaining 10 clones were rejected due to diseases, pith and poor growth characteristics.

In set-III, 14 clones along with two standard varieties HSF-240 and CPF-247 were studied. Out of which 4 clones i.e. S2012-M-1046. S2012-SL-1071, S2012-M-1362 and S2012-M-1379 were selected and promoted to semi-final trial for further study on the basis of good performance. The clones S2012-M-1046 gave higher cane yield (97.63 t ha^{-1}) with 12.64 t ha^{-1} sugar yield which was followed by S2012-SL-1071 with cane yield of 85.71 t ha^{-1} and 10.52 t ha^{-1} sugar yield. The remaining 10 clones were rejected due to smut, red rot, pith and poor growth yield and quality performance.

In set-IV, 5 clones alongwith two standard varieties HSF-240 and CPF-247 were studied. Out of which one clone, S2011-FD-18 was selected and promoted to semi-final varietal trial for further study on the basis of good performance. The clone S2011-FD-18 gave higher cane yield of 114.40 t ha^{-1} with 13.20 t ha^{-1} sugar yield.

The remaining 4 clones were rejected due to smut, red rot, pith and poor crop stand. The parameters studied in the experiment are as under:

Growth Performance

In agronomic practices, the growth performance is character that affect the yield of cane crop. Growth habits, erectness, inter-nodal length, girth of cane, length of cane and stooling depends upon genetic makeup which may be detected by overall performance of clone. In set-1, clones S2012-SL-280, S2012-SL-424 S2012-SL-426, S2012-SL-443, S2012-M-622 and S2012-M-632, in set-II clones, S2012 M-780, S2012-M-791, S2012-M-799 and S2012-SL-883, in set-III clones S2012M-1046, S2012-SL-1071, S2012-M-1362 and S2012-M-1379, in set-IV clone S2011-FD-18 showed good performance than others.

Pithiness

Hollow stem of cane is negative character, leads to lodging, disease infestation and lowers the cane quality. In the trial five clones were rejected due to pithiness.

Arial Roots

These are secondary roots which spoil the quality of cane as well as lowers the growth speed and deteriorate crop stand. One clone was rejected due to carrier of this bad character.

Disease Infestation

In the trial thirteen clones were rejected due to presence of smut.

Splits

The splits on the stem of cane deteriorate cane quality as well as tissues due to increase in transpitration rate. one clone showed deep splits / cracks and were rejected.

Lodging

Lodging exerts harmful effects on sugar yield, spoils cane quality, brix % and growth of cane crop. Seven clones showed low resistance to lodging and were rejected.

CONCLUSION

- In the trial forty seven clones of sugarcane were studied.
- Fifteen clones were selected and promoted for further study in semi final trial.
- The remaining thirty two clones were rejected due to disease susceptibility, pith, lodging and poor growth habits.

Table-1 Results of preliminary varietal trial (NURSERY-III) Set-I

Sr. No.	Variety / clone	Germination %	Tillers per plant	Cane count (000 ha^{-1})	Cane yield (t ha^{-1})	Sugar recovery %	Sugar Yield (tha^{-1})	Remarks
1.	S2012-SL-132	31.38 ab	0.56 d	55.96 bcd	46.97 c	12.51 cde	5.88 e	Rejected due to smut and pith
2.	S2012-SL-280	35.11 a	2.06 ab	63.05 ab	68.16 ab	12.26 de	8.36 bc	Selected and promoted
3.	S2012-SL-332	31.28 ab	0.74 cd	38.47 de	33.89 d	13.02 abcd	4.38 f	Rejected due to smut
4.	S2012-SL-424	33.87 a	1.56 bc	67.86 ab	73.83 a	13.36 abc	9.86 a	Selected and promoted
5.	S2012-SL-426	30.51 ab	1.76 ab	62.27 ab	69.61 a	13.91 a	9.66 a	Selected and promoted
6.	S2012-SL-432	33.48 ab	1.96 ab	53.46 bcd	52.01 c	13.12 abcd	6.80 de	Rejected due to high lodging, bud sprouting and poor brittleness
7.	S2012-SL-441	33.12 ab	0.56 d	32.91 e	22.57 ef	12.84 bcde	2.87 gh	Rejected due to poor growth, thin cane and poor cane stand.
8.	S2012-SL-443	36.03 a	1.40 bc	70.67 ab	72.92 a	13.69 ab	9.98 a	Selected and promoted
9.	S2012-M-622	33.89 a	2.43 a	62.56 ab	67.10 ab	13.20 abcd	9.09 ab	Selected and promoted
10.	S2012-M-626	33.12 ab	1.37 bcd	57.21 bc	30.27 de	13.15 abc	3.98 fg	Rejected due to lodging and pith
11.	S2012-M-630	31.28 ab	1.48 bc	24.98 e	22.10 f	12.29 de	2.72 h	Rejected due to smut
12.	S2012-M-632	40.63 a	1.87 ab	61.80 ab	67.60 ab	12.51 cde	8.45 b	Selected and promoted
13.	S2012-SL-695	32.51 ab	0.74 cd	62.49 ab	60.69 b	12.01 e	7.29 cd	Rejected due to smut, bud sprouting and lodging
14.	S2012-M-770	21.16 b	0.78 cd	41.38 cde	28.73 def	12.88 bcde	3.70 fgh	Rejected due to lodging and pith
15.	HSF240 (Std.)	41.25 a	1.38 bcd	71.26 ab	71.53 a	13.58 ab	9.71 a	Check
16.	CPF247 (Std.)	37.27 a	1.71 ab	78.61 a	70.58 a	12.77 bcde	9.44 ab	Check
	LSD at 0.05	**12.602**	**0.8281**	**16.47**	**7.8103**	**1.003**	**1.1137**	

Table-2 Results of preliminary varietal trial (NURSERY-III) Set-II

Sr. No.	Variety / clone	Germination %	Tillers per plant	Cane count (000 ha^{-1})	Cane yield (t ha^{-1})	Sugar recovery %	Sugar Yield (tha^{-1})	Remarks
1.	S2012-M-777	37.57 abcde	1.24 bcde	25.99 f	37.57 defg	12.86 ab	4.78 def	Rejected due to smut and high lodging trend
2.	S2012-M-780	57.65 a	0.90 de	74.99 ab	72.48 ab	13.30 a	9.66 ab	Selected and promoted
3.	S2012-M-787	19.43 de	2.08 a	19.44 f	12.51 h	13.37 a	1.69 h	Rejected due to poor cane stand and growth
4.	S2012-M-791	44.93 abc	1.25 abcde	75.27 ab	73.35 ab	12.64 ab	9.19 ab	Selected and promoted
5.	S2012-M-792	32.29 bcde	0.91 de	29.85 f	21.68 gh	13.65 a	2.97 fgh	Rejected due to poor cane stand, small internode and poor bud shape
6.	S2012-M-794	45.08 abc	1.10 bcde	65.97 bcd	63.27 bc	12.80 ab	8.42 bc	Rejected due to smut
7.	S2012-M-799	49.83 ab	1.77 abc	88.87 a	86.67 a	13.28 a	11.61 a	Selected and promoted
8.	S2012-M-814	29.44 bcde	1.60 abcde	53.87 cde	45.76 de	12.92 ab	5.97 cde	Rejected due to deep splits and thin cane
9.	S2012-SL-844	45.10 abc	1.42 abcd	49.73 de	33.28 efg	12.89 ab	4.30 defg	Rejected due to high lodging and small internode size.
10.	S2012-SL-847	27.14 cde	0.95 cde	45.35 e	42.31 def	12.91 ab	5.45 bef	Rejected due to smut and hairy leaves
11.	S2012-SL-852	42.87 abc	0.85 de	65.71 bcd	52.61 cd	12.65 ab	6.64 cd	Rejected due to smut
12.	S2012-SL-864	34.64 bcde	0.88 de	22.40 f	28.43 fgh	13.31 a	3.78 efgh	Rejected due to pith and poor growth
13.	S2012-SL-883	47.53 abc	1.14 bcde	67.96 bc	66.98 bc	12.17 b	8.14 bc	Selected and promoted
14.	S2012-SL-911	16.72 e	0.59 e	14.48 f	15.07 h	12.68 ab	1.92 gh	Rejected due to very poor growth, thin cane and smut
15.	HSF240 (Std.)	36.85 abcde	1.86 ab	68.62 bc	74.48 ab	13.34 a	9.94 ab	Check
16.	CPF247 (Std.)	40.63 abcd	1.85 ab	72.82 ab	70.61 ab	13.33 a	9.46 ab	Check
	LSD at 0.05	**21.628**	**0.8348**	**15.03**	**17.099**	**1.0218**	**23.36**	

Table-3 Results of preliminary varietal trial (NURSERY-III) Set-III

Sr. No.	Variety / clone	Germination %	Tillers per plant	Cane count (000 ha^{-1})	Cane yield (t ha^{-1})	Sugar recovery %	Sugar Yield (tha^{-1})	Remarks
1.	S2012-M-1046	44.47 ab	1.44 a	113.18 a	97.63 a	12.95 ab	12.64 a	Selected and promoted
2.	S2012-SL-1071	37.11 bc	1.44 a	72.91 b	85.71 ab	12.77 abc	10.52 ab	Selected and promoted
3.	S2012-SL-1210	19.01 e	0.36 f	30.55 efg	11.79 j	13.17 a	1.55 i	Rejected due to smut and poor cane stand
4.	S2012-SL-1238	25.91 de	0.49 f	26.38 fg	11.79 j	11.90 d	4.42 fgh	Rejected due to poor bud shape and poor cane stand
5.	S2012-SL-1244	30.47 cd	1.23 cd	31.24 defg	34.40 fgh	12.98 ab	4.45 fgh	Rejected due to smut and poor cane stand
6.	S2012-BD-1311	24.38 de	1.34 abc	44.58 cdef	36.05 fg	12.36 bcd	4.53 fgh	Rejected due to poor bud shape and small internode
7.	S2012-M-1327	25.30 de	1.23 bcd	53.74 bcde	47.15 ef	13.14 a	6.22 defg	Rejected due to high pith, thin cane and smut
8.	S2012-M-1332	24.84 de	1.10 d	47.82 cdef	29.39 ghi	11.95 d	3.49 ghi	Rejected due to thin cane, high lodging and poor cane stand
9.	S2012-M-1333	23.62 de	0.34 f	25.00 fg	19.05 hij	12.94 ab	5.28 efg	Rejected due to poor bud shape and poor cane stand
10.	S2012-M-1341	31.28 cd	0.68 e	23.75 fg	17.01 ij	13.21 a	2.27 hi	Rejected due to poor growth and cane
11.	S2012-M-1346	29.44 cd	1.21 cd	63.50 bc	63.77 cd	13.26 a	8.45 bcd	Rejected due to aerial roots, thin cane and lodging
12.	S2012-M-1362	38.57 bc	1.42 ab	47.74 cdef	71.41 bcd	12.79 abc	9.06 bc	Selected and promoted
13.	S2012-M-1379	51.06 a	1.34 abc	62.21 bc	72.65 bc	12.74 abc	9.24 bc	Selected and promoted
14.	S2012-M-1380	28.99 cde	0.52 ef	19.44 g	12.45 j	12.10 cd	1.50 i	Rejected due to poor cane stand and smut
15.	HSF-240 (Std.)	36.55 bc	1.22 cd	63.18 bc	56.61 cde	13.16 a	7.46 cde	Check
16.	CPF-247 (Std.)	30.62 cd	1.23 cd	55.55 bcd	56.28 de	12.74 abc	7.18 cdef	Check
	LSD at 0.05	10.237	0.1854	21.85	16.215	0.7181	2.7933	

Table-4 Results of preliminary varietal trial (NURSERY-III) Set-IV

Sr. No.	Variety / clone	Germination %	Tillers per plant	Cane count (000 ha^{-1})	Cane yield (t ha^{-1})	Sugar recovery %	Sugar Yield (t ha^{-1})	Remarks
1.	S2012-SL-1419	26.57 c	0.40 d	31.17 e	25.79 e	12.95 ab	3.29 d	Rejected due to poor growth and poor cane stand
2.	S2011-FD-18	58.51 a	2.24 a	111.80 a	114.40 a	11.59 b	13.20 a	Selected and promoted
3.	S2011-AUS-87	39.28 b	0.40 c	40.44 d	48.53 d	11.51 b	4.61 d	Rejected due to high pith and small internode
4.	HoTh-2109	48.37 ab	1.91 b	58.81 b	55.60 cd	13.08 ab	7.47 c	Rejected due to poor bud shape and poor cane
5.	HoTh-409	44.77 b	1.51 c	49.99 c	53.18 cd	12.61 ab	6.74 c	Rejected due to smut
6.	HSF-240 (Std.)	42.59 b	1.32 c	58.32 b	70.21 b	13.95 a	9.80 b	Check
7.	CPF-247 (Std.)	48.15 ab	1.28 d	60.79 b	66.54 bc	12.03 b	8.00 bc	Check
	LSD at 0.05	**11.140**	**0.2737**	**2.979**	**13.752**	**1.6680**	**1.9096**	

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Sugar INDUSTRY ABSTRACTS

A tool for converting conventional sugarcane trial results into economic terms

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Results from sugarcane field trials are conventionally presented in cane and/or sucrose yield terms. The availability of a tool to convert conventional field-trial data into economic terms would enable researchers to rapidly perform economic calculations and routinely include economic considerations into recommendations to end-users. This paper outlines the nature of such a tool that was developed at the South African Sugarcane Research Institute (SASRI), and reports on its performance when tested across a series of sugarcane trials. The MS Excel-based calculator allows for the definition of treatments, together with the input of measured trial cane yields and cane quality defined as recoverable value content (RV%). Production factors and their related costs are listed sequentially from land preparation through to cane delivery to mills. Users are able to activate any given production factor depending on the type of trial being considered. Treatment differences (cost/ha) for that specific factor are then defined further. The tool considers all harvesting, loading, and transport costs associated with higher cane-yielding treatments, together with any product and application cost differences to calculate a gross margin (GM) for all treatments. Data from variety, chemical ripener, nematicide, mulch-retention, harvest-age, and crop-nutrition field trials were analysed using the calculator. Data input consisting of trial parameter set-up and definition of treatments were completed in under 10 minutes for each trial, and the GM of each subsequent crop in a trial could be calculated in under another 2 minutes. In general, the GMs were well correlated to RV yields when using current production costs. However, sensitivity analyses showed that increases in treatment costs, cane yield and its related harvesting and transport costs may offset future GM benefits of some treatments. Foliar application treatments generally produced much higher GMs compared with controls, even if product and application costs were doubled. Selected examples of the different applications of the calculator are illustrated and discussed. It is envisaged that the calculator will become a useful tool for researchers needing to improve the adoption of best management practices through economic reporting.

Carbon dioxide enrichment effects on the decomposition of sugarcane residues

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The aim of this study was to determine the decomposition dynamics of sugarcane residue under conditions of enriched atmospheric CO_2 concentration using a FACE facility (Free-Air Carbon Dioxide Enrichment). The experiment, conducted in Jaguariúna, São Paulo State, Brazil, using the ClimapestFACE facility, received two treatments: elevated CO_2 (550 ± 100 µmol mol^{-1}) and ambient CO_2 (400 µmol mol^{-1}), for a single amount (5 t ha^{-1}) of straw (cane trash), in a randomized-block design with six replications. Decomposition was determined by using litter bags with sampling at 0, 14, 36, 60, 90, 119, 179, 291 and 362 days after commencement and determining the remaining biomass (kg ha^{-1}), decomposition rate (%), constant k (kg.day^{-1}) and half-life (t1⁄2) of decomposition (calculated by first-order exponential model). Results showed significant statistical interaction among treatments, mainly from 90 to 179 days after the beginning of the experiment when the region had high precipitation and, coincidently, the highest straw decomposition rate (4%) at the ambient CO_2 concentration (400 µmol mol^{-1}). After that, there were no statistical

differences. Small differences between treatments were not significant to affect the overall behavior of the decomposition dynamic, which followed an exponential behavior, with the same k (0.002929 kg days^{-1}) for both treatments. Decomposition ratio was high (33%) during the first 36 days, but t1⁄2 was 237 days. Final decomposition was 69% with 1.5 t ha^{-1} of remaining biomass. We concluded that the increase of atmospheric CO_2 concentration (from 400 to 550 ± 100 µmol mol^{-1}) does not change the dynamic of sugarcane residue decomposition, which is exponential and has its highest biomass loss in the first 36 days after field deposition.

Genotype-by-environment interaction, adaptability stability of biomass sugarcane varieties in Mauritius

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Genotype-by-environment interactions (GEI) are a major issue in plant breeding that complicates selection and requires breeders to assess the adaptability and stability of promising genotypes before release. Different techniques have been developed to model and present GEI. Current trends involve the use of AMMI and GGE multivariate techniques that include good visualization tools to show major response patterns. In this study, 22 genotypes with high biomass potential were assessed over three harvest cycles for cane yield at five locations corresponding to the five major soil types in Mauritius, and analyzed for adaptation and stability. Analysis of variance confirmed the significance of the interactions between variety and location. The study gave preliminary indications of the presence of two mega-environments in Mauritius that correspond to the low-altitude dry lands in the northern plains and the more humid environments. Environments that were highly discriminating and those that were most representative for wide adaptation were defined. The best varieties overall were three West Indies clones, WI79460, WI79461 and WI81456, and two commercial varieties, R570 and M1400/86. The West Indies genotypes were found to be adapted to the humid and super-humid environments, while the commercial varieties had highest cane yield in the dry lands. AMMI and GGE analyses of GEI were found useful in proposing mega-environments in Mauritius and to improve precision in selection while reducing the cost by eliminating unnecessary test locations.

Addressing slow rates of long-term genetic gain in sugarcane

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For the last 50 years, rates of genetic gain in sugarcane breeding programs worldwide appear to be slow, particularly when compared with gains being delivered in some other crops. Likely reasons include the high proportion of genetic variation present as non-additive variation in sugarcane for key traits and long generation interval between crossing and parent selection. The high non-additive genetic variation, especially for cane yield, contributes to low narrow-sense heritability and means that selection of new parents based on phenotype poorly predicts breeding value. DNA markers may better predict breeding value because prediction models directly related to additive genetic effects (ie. presence versus absence of alleles) can be applied. An experiment was set up in test this hypothesis. A set of 1135 clones typical of those evaluated in stage 2 in the Australian breeding program was taken as a starting population, and cane yield and commercial cane sugar (CCS) measured in all clones. A set of 384 pre-selected DNA (DArT) markers was also screened across this population and genomic predictions of cane yield and CCS made. Progeny from 141 crosses derived from a subset of 41 clones were evaluated to measure breeding value. As expected, phenotypic performance of the 41 clones for cane yield or CCS

poorly predicted breeding value (r = 0.26, P<0.10; 0.02, ns; for CCS and cane yield, respectively), reflecting low narrow sense heritability. However genomic predictions using markers gave better predictions (r = 0.68*** and 0.35*, for CCS and cane yield, respectively). The results in this study are encouraging regarding the use of DNA markers for rapid improvement of parents. This is particularly so considering that an accurate marker-assisted breeding program should derive even more accurate predictions of breeding value, and use an approximately 3-year generation interval. Suggestions are made on how this may be done in practice.

Pilot-scale demonstration and economics of the inversion process for sugar and ethanol production

I O'Hara, D Rackemann, D Moller, Z Zhang, F Plaza, K Kitai, S Ohara and T Yasuhara
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A novel process for producing sugar and ethanol from high-yielding sugarcane called the Inversion Process has been developed previously. The process incorporates the use of an invertase-defective yeast to selectively ferment reducing sugars in sugarcane juice prior to crystallization to both produce ethanol and enhance the recovery of sugar from the process. To evaluate the technical and economic potential of the technology, the impacts of the Inversion Process on juice and syrup quality, crystal sugar production and recovery were evaluated using a three massecuite boiling scheme at pilot scale and techno-economic modelling was undertaken based on the results obtained. The Inversion Process decreased reducing sugar concentrations by >90%, which resulted in significant purity increases in clarified juice, syrup and A and B massecuites. These outcomes resulted in improved crystallization performance and reduced recycling of impurities. Lower C massecuite and C molasses purities were also achieved resulting in a significant impact on processability and recovery of sugar from C massecuite. Preliminary economic modelling showed the potential for very significant industry benefits with financial benefits accruing from increased sugar production and the production of ethanol from reducing sugars with the benefits of most significance for factories processing low-purity or high-yielding sugarcane. This paper reports on the demonstration of the Inversion Process in Australia and potential technical and financial impacts of the Inversion Process on the operation of sugar factories are discussed.

Long-term stability of the inversion process for sugar and ethanol production in an existing Japanese sugar mill

S Ohara, K Kitai, A Sugimoto, Y Hamada, H Hidaka, M Shioura, I O'Hara and T Yasuhara
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In order to utilize sugarcane with a high reducing-sugar content as the raw material for sugar production, a new technology called the 'inversion process' has been developed. This new technology aims to enhance raw sugar yield via removal of reducing sugars through selective ethanol fermentation using an invertase-defective yeast, prior to sugar crystallization. To assess the feasibility of the inversion process technology in an existing sugar mill, a test of continuous and repeated-batch fermentation using clear juice was undertaken at a pilot-scale facility at the Shinko Sugar Mill in Japan. Batch fermentation trials were performed at 35°C for 1.5-3 h and repeated 70 times in a 2000 L fermenter using the same culture of invertase-defective yeast strain GYK-10. To confirm the long-term stability of the selective fermentation, the concentrations of saccharides and ethanol in the fermenter were measured every hour and the residual sucrose ratio and the reducing sugars removal ratio were calculated. Each batch was checked for the presence of contaminating bacteria. The results showed that 88.4% of reducing sugars were converted to ethanol and 99.5% of sucrose remained throughout the 70 consecutive batch fermentations. This

indicates that the saccharometabolism selectivity of GYK-10 is stable. Although contamination by some microorganisms, such as Clostridium beijerinckii, Bacillus simplex, and Bacillus brevis, was observed, this had little influence on the fermentation outcomes. This paper reports on the feasibility of using the inversion process in an existing sugar mill.

Geostatistical tools for the assessment of the incidence of Diatraea saccharalis in sugarcane in Cuba

ZL Vega, CG Rojas and MR Regal
Proceedings of the International Society of Sugar Cane Technologists, volume 29, 2016

The aim of this work was to explore the advantages offered by geostatistical techniques for spatial variability analysis of the incidence of D. saccharalis in sugarcane. Data from pest percentage of intensity that expresses the damage recorded in commercial fields of Granma province in Cuba were used during 2010-2011 and 2011-2012 seasons for this study. Additionally, records of field releases of both parasitoids Lixophaga diatraeae Townsend (Diptera: Tachinidae) and Tetrastichus howardi Olliff (Hymenoptera: Eulophidae) to control the stemborer during four phytosanitary seasons, were considered. Data were analysed using the statistical software SPSS v.11.5 as well as Mapinfo Vertical Mapper and Variowin for estimation map generated by kriging. Results showed that the Gaussian model was the best fit graphical representation of pest intensity in the study period. The most adequate distances for pest intensity evaluation determined by resulting correlations in the variogram were 1968.75 and 4804.84 m. Estimation maps that were generated allow to clearly display the behaviour of D. saccharalis. They allowed understanding and improving the strategies for pest control in real time. One of the most important result is the optimisation and redirection of the application of biological control to the most infested areas. Mapinfo Vertical Mapper and Variowim geostatistical tools also set priorities to improve pest control measures in these areas.

INTERNATIONAL EVENTS CALENDAR

2018 MEETINGS AND CONFERENCES

February 6-7: Louisiana Division ASSCT, Baton Rouge LA, USA ASSCT

March 25-28: 77th Sugar Industry Technologist Conference, Bonita Springs, Florida, USA SIT

April 12: AVH Symposium 2018,Reims, France AVH

May 15-18: ASCPC Conference, Le Pavillon Hotel, New Orleans, LA, USA Contact us

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

June 27-29: Sugar Processing Research Institute (SPRI), 2018 Conference,Bonita Springs, FL USA Charley@sugarjournal.com

August 3-8: 35th International Sweetener Symposium, The Grand Traverse Resort, Traverse City MI USA, ASA

September 24-28: Association of Latin American Sugar Technologists (ATALAC), Colombia ATALAC

STORY OF SWEETS

i. Moong Dal Halwa

Ingredients

1 tin	Nestle Milkmaid Sweetened Condensed Milk
1 cup	MILKMAID Pure Ghee
3 cups	Milk
1 cup (150 gm)	Moong Dal (dhuli)
1/2 tsp	Elaichi (Cardamom) Powder
3 tbsp	Badam (Almonds) cut into slivers
3 tbsp	Kishmish (Raisins)
3 tbsp	Pista chopped

Directions

* Clean and soak the moong dal for 30 minutes, drain and grind to a coarse paste. Fry the dal paste in ghee, till it turns golden brown.
* Add the milk and cook on low flame, stirring continuously, till milk dries up. Add the Nestle Milkmaid Sweetened Condensed Milk and cook, stirring continuously, till desired consistency is reached.
* Mix well and transfer to a bowl. Garnish with the almonds. raisins and pistachio.

ii. Sohan Halwa

Ingredients

Arrowroot 2 cups + 1
Sugar
Tartaric acid 1/2 teaspoon
Sugar 4 1/2 cups
Ghee 1 1/2 cups
Orange colour 1/2 teaspoon
Melon seeds (magaz) 2 tablespoons
Cashewnuts chopped15
Almonds chopped15
Pistachios chopped20

Directions

* Soak arrowroot in four cups of water for half an hour. Remove excess water from top.
* Grease a tray or a thali. Soak tartaric acid. Mix sugar with half its quantity of water and cook to make syrup. Add tartaric acid and cook till it reaches one string consistency. Add edible orange colour to the syrup and mix.
* Add arrowroot little by little and cook stirring continuously. Meanwhile roast melon seeds in another pan. Add cashewnuts, almonds and pistachios and roast till a nice aroma is given out.
* When the arrowroot begins to thicken, add ghee, a little at a time, and cook stirring continuously till all the ghee has been incorporated. When the mixture begins to form into a ball add three fourths of the roasted nuts and mix.
* Pour onto the greased tray or thali and spread. Smoothen the top. Sprinkle the remaining nuts on the top. Cool slightly and cut into diamonds or squares.
* Separate the pieces when cooled and serve.

GUIDELINES FOR AUTHORS

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