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A STUDY IN THE DEXTRAN CONTENT IN SUGAR CANE AND ITS CONTROL IN SANGHAR SUGAR MILLS LTD., SANGHAR
H.A. Naqvi, M. Hashim Rajar, Hayatur Rahim Khan and Rao Mohammad Shafiq

ABSTRACT

With the proper cane management, improved hygiene at the mills and process streams, etc., at the Sanghar Sugar Mills Ltd (SSML), the problem of very high content of dextran in sugar cane i.e. above 18,000 ppm was checked and brought down to a level of 3000. Due to reduction in the dextran content in cane, the cane juice pH increased by 0.30, the final molasses purity decreased by 30, steam consumption decreased by 12%, purity drop between crusher juice and mixed juice decreased by 21%, the process house including centrifugals were able to accommodate higher cane crushing, the boiling house and overall efficiencies increased by 10%, the sugar recovery % cane increased by 0.57, the colour of sugar decreased by 50% and pol of white sugar increased by 0.20.

INTRODUCTION

The SSML was confronted with the problem of high dextran content i.e. above 18,000 ppm in sugar cane. This was creating serious problems in processing of the cane, pan boiling, difficulty in purging of massecuites in sugar centrifugals, reduced crushing capacity, low sugar recovery % cane, higher consumption of steam, lower boiling house & overall efficiencies, higher purity of final molasses and high color of sugar. From crushing season 2007-08 onward a comprehensive plan was chalked out to control the dextran in sugar cane and avoid its harmful effects in milling, boiling house operation and the overall working.

REVIEW OF LITERATURE

Dextran, a gummy substance, is a polymer of glucose and is produced by micro-organisms as a result of post harvest deterioration of sugar cane. Sucrose (disaccharide) is biologically degraded into glucose and fructose (monosaccharides), particularly by leuconostoc mesenteroides, which produces dextran sucrose to cause polymerization of glucose into a polysaccharide called dextran. It is melassigenic and carries through the manufacturing process into sugar. Dextran becomes a problem when the dextran content of juice rises above 2000mg/kg. Due to increased dextran levels, the factory capacity is reduced with increased viscosities, increase evaporation and boiling time, decrease in crystallization rate. Besides processing problems, dextran causes great loss to sugar in cane. Dextran also increases the polarization reading and interferes in the sucrose analysis (Gugliemone et al, 2000 and Rein, 2007).

Formation of dextran starts in the cane after harvesting but its multiplication takes place much faster after 6 hours of harvesting. Dextran is a finished product of the microbial infection caused through bacteria. Dextran is commonly produced in sugar processing streams by bacteria of the Genera Lactobacillus, Leuconostoc and Streptococcus.
However, of these Leuconostoc Mesenteriod (LM) is most effective organism in sugar cane which degrades its sucrose contents and produces dextran. The LM duplicates its population every 10 minutes and almost 3 – 4 Kg of sucrose is lost for each Kg of dextran formation. LM grows at 60oc feely or below and at slightly acid to neutral pH, in cane tissues exposed to the environment, also in cane juice and low brix solutions. The bacteria mainly Leuconostoc species enter the cane at places of exposed tissues caused by machine harvesting, cutting, burning, freezing, disease and pests. Any delay in the cut to mill time allows the bacteria to proliferate and the dextran level soar, especially in the wet muddy cane. (Cuddinhy, 2001; Pulido and Raza, 1987).

Dextran in juice, syrup and sugar can cause false pol, because dextran polarizes about 3 times as much as sucrose and gives a high pol. Dextran in solutions increase viscosity, lowers evaporation rates and reduces heat transfer. It slows boiling time and purging in centrifugals. It is estimated that for every 300ppm dextran in syrup there is a 1% increase in the molasses purity (William, 2001). Level of dextran in cane is co-related with from cut to crush time. It is likely to build up in numbers on wet, muddy cane, on cane with lot of exposed tissue surface or injury from frost, disease or pests. Also dextran content of cane varieties with hard rind contained lower quality of dextran as compared to soft rind cane varieties (Imtiaz Ali, 1987, Hayat 2006).

High level of dextran has been found to lead to higher final molasses purites. It is expected that levels of above 10,000 mg/kg dextran on solids, the target purity should increase by 0.2 units for each increase in dextran level of 1000 mg/kg dry solids (Rein, 2007).

**WORKING DATA**

The SSML commenced its operation during 1987-88 with a crushing capacity of 5000 tons cane per day (tcd) following defection remelt phosphotation process for production of white sugar of 99.8o pol and 60 ( + 20) ICUMSA color. The technical results obtained during the first 20 years of operation (1987-88 to 2006-07) of the SSML are given as under (Table-1).

---

**Table-1 SSML technical results, 1987-88 to 2006-07**

<table>
<thead>
<tr>
<th>Description</th>
<th>Average of Five seasons (per season)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cane Crushing/ day, tons</td>
<td>1987-88 to 1991-92 to 1992-93 to 1996-97 to 1997-98 to 2001-02 to 2002-03 to 2006-07</td>
</tr>
<tr>
<td>Sugar recovery % cane</td>
<td>2591 2966 3360 3472</td>
</tr>
<tr>
<td>Purity drop from crusher to mixed juice</td>
<td>8.99 9.17 8.92 9.00</td>
</tr>
<tr>
<td>Steam consumption % cane</td>
<td>1.58 1.52 1.46 1.52</td>
</tr>
<tr>
<td>Av. Purity drop from massecuite to molasses</td>
<td>n/a 72 70 66</td>
</tr>
<tr>
<td>Final molasses purity</td>
<td>14 – 16 14 – 16 14 – 16 14 – 16</td>
</tr>
<tr>
<td>Boiling house efficiency %</td>
<td>36.35 36.14 36.61 36.16</td>
</tr>
<tr>
<td>Overall efficiency %</td>
<td>81.66 82.54 83.21 84.00</td>
</tr>
<tr>
<td>Color of raw A-sugar, ICUMSA</td>
<td>74.50 76.78 77.31 79.27</td>
</tr>
<tr>
<td>ICUMSA Color of R1, R2 &amp; R3 white sugars</td>
<td>850 – 1000 850 – 1000 850 – 1000 850 – 1000</td>
</tr>
<tr>
<td>Polo of white sugar</td>
<td>99.4 – 99.7 99.4 – 99.7 99.4 – 99.7 99.4 – 99.7</td>
</tr>
</tbody>
</table>
From the available data (table-1), it will be noted that: Cane crushing was low i.e. 70% of the capacity. Sugar recovery % was low i.e. about 9% on cane. Purity drop from crusher juice to mixed juice was high, i.e. + 1.5o. Steam consumption % cane was high i.e. 66%. Final molasses purity was very high i.e. +36o. The boiling house efficiency was low i.e. 84%, and overall efficiency was below 80%. The purity drop between all the A, B & C massecuities and relative molasses was low i.e. 14-16o. The ICUMSA color of raw A-sugar was high i.e. 850-1000, white sugar 50-120, and the pol of white sugar was low i.e. 99.4 o - 99.7o. Considering all the above points during 2006-07 season, the attention was focused towards improving the working efficiency of SSML with special reference to increasing the productivity, the sugar recovery and sugar quality, and minimizing the sugar losses, etc. With the physical observations and analysis of the sugar cane being crushed in the SSML, it was noted that: Old cut cane, borer pest damaged, with lot of top, and trash was coming to the mills. There was a long queue of cane loaded vehicles (more than 400 at a time with +15 tons cane weight each) were waiting for their turn at the mills. On survey of cane farmers fields, huge heaps of old harvested cane was observed. On analysis of cane juice, the pH was found to be between 4.9 – 5.2 i.e. a sign of old harvested and pest damaged cane. As there was no arrangement in the SSML for analysis of dextran in cane, it was got analysed from neighboring sugar mills, the Agricultural University and Agricultural Research Institute. The results obtained showed alarmingly high dextran content in cane juice ranging from 9259 to 23928ppm. The color of cane syrup was dark, and viscous dark colored massecuite was boiled in the vacuum pans. The viscous massecuite was creating difficulties in centrifugal purging with reduced capacity and extra washing.

**WORK PLAN**

With the available data, a work plan was prepared and followed from crushing season 2007-08 onward, main of them are:

a. Proper, computerized cane procurement program was chalked out and followed.

b. Regular visits to cane farmers and their cane fields by the SSML staff was organized to make them observe the cane supply program and manage harvesting accordingly.

c. Check the pests and diseases of sugar cane with the use of healthy seed, use of pesticides and biological control, etc.

d. The Cane Department was strengthened and re-organized with the establishment of a cane development cell.

A biological control laboratory was established at the SSML to produce Trichogramma Chilonis cards which were distributed to sugar cane farmers at 50% subsidised rates. Literature, wall posters, banners, etc on cultivation of sugar cane, plant protection, variety selection, seed treatment, pest management and other agronomic practices, etc were distributed freely to the sugar cane farmers of the area. Get-together meetings of the cane farmers were organized at the SSML and also at the farms of prominent cane farmers of the area to make them aware of latest agronomic practices and the SSML requirements. It was addressed by prominent agricultural scientists.

a. Arrangements for analysis of dextran in the SSML chemical laboratory was made, and dextran was analysed on regular basis, at least once in every shift.

b. Analysis of pH of crusher juice was made a routine every hour, and the purity
drop from crusher juice to mixed juice was also noted on hourly basis. Proper sanitation at the mills and process house was maintained with hot water washing, steaming, and use of bleaching powder and biocides. However, the use of enzyme dextranase to check dextran in process was not considered being an expensive treatment.

RESULTS AND DISCUSSION

As a result of all the above mentioned measures taken from 2007 onwards, including the procurement of healthy, fresh & clean cane, improving the sanitation at the mills and the process streams, reduction in cut to crush time, etc., marked improvements were observed in the overall working of the SSML. The results obtained between seasons 2007-08 to 2011-12 and compared with previous 20 seasons 1987-88 to 2006-07 are discussed herewith:

Dextran: The dextran content in cane juice reduced to 3588ppm during 2008-12 as compared to +18965 previously. This resulted in the improvements of overall working and the production results. Given below are the analysis results of dextran in cane juice from 2006 to 2012. (Table-II)

Table- 2  
Dextran content in SSML sugar cane 2006 to 2012

<table>
<thead>
<tr>
<th>Description</th>
<th>Dextran in cane juice ppm / Brix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006-07</td>
</tr>
<tr>
<td>Sample No. 1</td>
<td>21093</td>
</tr>
<tr>
<td>Sample No. 2</td>
<td>15563</td>
</tr>
<tr>
<td>Sample No. 3</td>
<td>9259</td>
</tr>
<tr>
<td>Sample No. 4</td>
<td>23928</td>
</tr>
<tr>
<td>Sample No. 5</td>
<td>18030</td>
</tr>
<tr>
<td>Sample No. 6</td>
<td>20711</td>
</tr>
<tr>
<td>Sample No. 7</td>
<td>23478</td>
</tr>
<tr>
<td>Average</td>
<td>18965</td>
</tr>
</tbody>
</table>

Juice purities: The purity difference from crusher juice to mixed juice dropped to 1.25 as compared to previous + 1.50 i.e. a decrease of 21% (Fig-01).

pH of cane juice: The pH of the cane juice improved to 5.4 and 5.5 i.e. near the natural pH of the juice during 2007-08 to 2011 as compared to 4.9 – 5.2 pH in 1987-2007 seasons i.e. an increase of 8%.

Cane crushing: During 2007-08 to 2011-12 the cane crushing rate of 4447 tcd was achieved which was an increase of 29% as compared to 2002-03 to 2006-07 seasons. One of the reasons being that the boiling house was able to accommodate higher crushing due to lower dextran in cane, easy pan boiling, good quality massecuite, easy purging at centrifugals, etc.

Steam consumption: With the decrease in the dextran content, there was improvement in evaporation, smooth pan boiling and ease at the purging of
massecuites in centrifugals, etc. Therefore, there was a decrease of 12% in the steam consumption during 2007-08 to 2011-12 as compared to 2002-03 to 2006-07 seasons (Fig-02).

Sugar recovery % cane: The sugar recovery % cane during 2007-08 to 2011-12 increased by 0.57% i.e., an increase of 6% as compared to 2002-03 to 2006-07 seasons (Fig-03). This was due to fresh, clean and healthy cane with low dextran content and improvements in the boiling house and overall efficiencies, etc.

Massecuite and molasses purities: The purity drop from massecuites to molasses during 2007-08 to 2011-12 remained between 18-20%. This was an increase of 12% as compared with 2002-03 to 2006-07. Similarly the final molasses purity also decreased by 10%. (Fig-04)

Boiling house and overall efficiencies (BHE & OAE): During 2007-08 to 2011-12, the B.H.E. and O.A.E. increased to 85.45 and 81.37 respectively (Fig-05). This was an increase of 10% over the 2002-03 to 2006-07 seasons.

Sugar quality: During 2007-08 to 2011-12, the ICUMSA color of white sugar improved to 30-60 and the polarization to 99.8 as compared to 50-120 color and 99.4 – 99.7 pol sugar during 2002-03 to 2006-07 seasons.

SUMMARY AND CONCLUSION

Various measures were taken to reduce the high content of dextran in sugar cane
coming to the SSML e.g. to procure healthy, clean and fresh cane, reduce the time between harvesting of sugar cane and milling of the same, and improve the hygiene at the mills and process streams. This resulted in decrease in dextran content in cane by +500% and improvements in the overall working results of the SSML, i.e.

- Decrease in purity drop from crusher juice to mixed juice by 0.27%.
- Decrease in steam consumption % cane by 12%.
- Decrease in color of sugar by 50%.
- Increase in the pol of white sugar by 0.2o.
- Decrease in final molasses purity by 3.01o.
- Increase in purity drop from massecuite to molasses by 12%.
- Improvements in the color of cane syrup and massecuites, easy vacuum pan boiling and purging at centrifugals due to low viscosity, etc.

Increase in sugar recovery % cane by 0.57o.
Increase in boiling house and overall efficiencies by 10%.
Increase in the cane juice pH by 0.3o.

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EVALUATION OF ELITE SUGARCANE CLONES FOR YIELD AND QUALITY ATTRIBUTES UNDER SEMI ARID CONDITIONS

Muhammad Aslam*, Naeem Ahmad*, Muhammad Kashif Hanif* and Zulfiqar Ali**
*Sugarcane Research Station, Khanpur** Sugarcane Research Institute, Faisalabad

ABSTRACT

The trial on collative performance of various sugarcane varieties was conducted at Sugarcane Research station, Khanpur during the year 2012-13 under the semi arid conditions of southern Punjab. The varieties included in the trial were S2006SP.30, S2006US.272, S2006US.321, S2006US.640, S2006US.641, S2005US.54, S2003US.718 and HSF.240. The results elucidate that the new promising Sugarcane Variety S2006US.272 with average germination (45.42%), best tillering (2.55 per plant), comparable hundred cane weight (99.33 kg) and stand (104.82 thousand/ha), maximum cane yield (104.07 t/ha) and better CCS (12.28%) excelled the tested genomes in sugar production (12.77 t/ha). It was closely followed by the check variety HSF.240. Hence the studies predict that the new variety S2006US.272 with 11.72 and 13.51 % more cane and sugar yield respectively over control is capable of replacing the check variety. A wide scale testing of the promising variety in different agro ecological zones is, however, invited for regional adoptability.

Key Words: Variety, CCS, Millable canes, Cane Yield, Sugar Yield.

INTRODUCTION

Sowing of a single sugarcane variety, though high yielding, on a vast agro climatic zone is always at peril. The evolution of new breeds of insect pests, the sudden outbreak of a disease or exposure to unusual environmental conditions in these areas may culminate to a condition of minimal productivity which may wreak economic havoc in the farming community. Besides the importance of cultural practices, gain in the yields is due to improved varieties. The improvement in sucrose contents from 9.1 to 13.5 percent in Louisiana is through breeding and selection (Broux, 1984). The evolution of sugarcane varieties higher in cane and sugar yield is, therefore, need of the day to improve farmer productivity and sugar mills efficiency. For this purpose a new sugarcane clone SPF-234 was compared by Aslam et al., (1998) with BL.4. The former variety on account of better germination and tillering coupled with better cane weight and sufficient stalk density out yielded all the tested varieties by producing an average stripped cane yield of 139.43 t/ha and mean sugar yield of 14.06 t/ha. Memon and Panhwar, 2004 tested ten sugarcane clones and concluded that HOTH.271, HOTH.236. HOTH.234 remained high cane yielder due to greater cane weight and density. In sugar recovery HOTH.2109 and 2119 excelled the tested clones. Malik and Gill, 2005 reported on the basis of yield and quality performance data for three years that five sugarcane clones CPD.01-346, CPD.01-294, CPD.01-319,CPD 01-349 and CPD.01-335 proved superior to the standard check. Soomro et al. 2005
conducted a field trial comprising of 15 sugarcane varieties from all over the country including Gulabi.95 as standard. Their results revealed that significantly high cane yield of 117.09 t/ha was obtained from variety S96SP.302 followed by LRK.2001,Q.88 and BF.138. The significantly higher CCS of 12.50 % was recorded for S95HS.185 while S86US.340, NSG.311 and Gulabi 95 ranked second, third and fourth, respectively. Afghan et al., (2010) studied the performance of new sugarcane varieties against the standard SPSG.26 and reported that NSG.311 gave significantly high cane yield of 126 t/ha for both plant and ratoon while sugar recovery of 10.45 % and 10.60% for plant and ratoon against standard check which gave a cane yield of 80 and 74 t/ha for plant and ratoon, respectively. The top yielder produced the maximum sugar yield (13 t/ha) followed by S96SP.302 (11 t/ha). Unar et al., (2010) studied the comparative performance of 9 promising sugarcane genotypes with Thatta-10. The cane yield data revealed that HOTH-348 remained at the top with average cane yield of 121.22 t/ha followed by HOTH-2109 and HOTH-349. The genotype HOTH-349 surpassed in CCS%(13.89). Bashar et al., (2011) conducted a comparative study with six sugarcane varieties and reported that variety ISD.32 produced significantly high cane yield (72.39 t/ha) followed by ISD.35 (64.00 t/ha) and ISD.33 (57.40 t/ha) primarily due to high number of millable canes per hectare. Gujar et al., (2011) obtained maximum average cane yield of 150, 131 and 130 t/ha from sugarcane varieties NSG.555, S97US.102 and HOTH-326, respectively. In quality analysis CP.80-1827 remained at the top by producing CCS of 15.30% followed by CP.89-1945 and CP.82-1172 with mean CCS of 14.73 and 14.59%, respectively while the check Thatta-10 produced an average CCS of 14.49%. Nadeem et al., (2011) compared quantitative and qualitative performance of sugarcane varieties. They recorded the highest cane yield of 119.50 t/ha from promising sugarcane variety S2001US.375 due to highest millable canes, better tiller formation and comparable germination. It was followed by S2001US.129 and S2001US.395. The top yielder surpassed the tested genotypes in sugar yield by producing 12.79 t/ha. Islam et al., (2013) studied the relative performance of 10 sugarcane varieties under water logged stress conditions and concluded that genotype I-231-03 out yielded all the strains in cane and sugar yield. Keeping in view the importance of varietal role in sugarcane production, the present study was undertaken to evaluate the performance of eight promising sugarcane varieties under hot dry climatic conditions of Southern Punjab.

**MATERIAL AND METHODS**

The present studies regarding the evaluation of elite sugarcane varieties were conducted at the experimental area of Sugarcane Research Station, Khanpur during Kharif 2012-2013. Seven promising sugarcane genotypes namely S2006SP.30, S2006US.272, S2006US.321, S2006US.640, S2006US.641, S2005US.54 and S2003US.718 were compared in yield and quality with the standard HSF.240. The experiment was sown on loamy soil by dry method during the third week of February in trireplicated RCBD arrangement with a net plot size of 3.6 x 10 m and harvested in December 2012. The test factor was allowed to grow under recommended inputs level. The required agronomic operations were performed as and when required. The germination and tillering data were recorded after 45 and 90 days of sowing while millable cane count, cane weight and yield were recorded at harvest. The juice of cane samples was analyzed for brix, pol, purity and CCS was worked out by
the following formula for quality evaluation.

\[
                 CCS = \frac{3P}{2} \left\{ 1 - \frac{(F + 5)}{100} \right\} - \frac{B}{2} \left\{ 1 - \frac{(F + 3)}{100} \right\}
\]

Where \( P \) = Pol percentage i.e., Sucrose percentage

\( F \) = Fibre percentage

\( B \) = Brix percentage

The data collected during the study were statistically analyzed using Fisher’s Analysis of Variance Technique and significant means were compared using Least Significant Difference (LSD) Test at 5% probability level Steel et al., (1997).

RESULTS AND DISCUSSION

The results regarding the physiological and chemical parameters embodied in Table 1 along with their statistical interpretation are discussed in the coming lines.

Germination

Germination is the most important phase in the crop husbandry. It directly affects the establishment of final plant stand per unit area. A shy germinating variety will often fall behind in final harvests. The data regarding the germination percentage (Table 1) of tested genomes show significant statistical differences. The highest germination of 47.85 and 47.71 has been recorded for S2006SP.30 and S2006US.640 which were insignificantly followed by S2005US.54 and S2006US.272. The lowest germination of 33.96 % has been exhibited by HSF.240. Aslam et al., (1998) and Nadeem et al., (2011) have also reported significant differences among the germination of sugarcane varieties.

Tillers per plant

Tillering potential of a sugarcane variety is undoubtedly one of the most convincing yield promoting characters. A high tiller producing cane variety will make up the deficiency in germination to a large extent and will also give better ratoon. Average number of tillers given out by the tested varieties ranged from 2.55 to 1.70 per plant as is explicit from the data embodied in Table 1. The differences among the genotypic means remained significant. The promising sugarcane clone S2006US.272 surpassed the collated varieties producing 2.55 tillers per plant. It was non significantly followed by HSF.240 and S2006US.321. The most poor tillering has been recorded for S2006US.640. These results are in line to those of Aslam et al., (1998) and Nadeem et al., (2011) who have also reported significant varietal difference in individual cane weight.

Cane Weight

A sugarcane crop with heavier stalks predicts a high final harvest provided the plant population remains the same. A perusal of the data embodied in Table 1 elucidate that the cane weight differences among the tested clones were gorgeous enough to reach a level of statistical significance. On an average the hundred cane weight varied from 78.33 to 100.67 kg. The genotypes S2006US.321 and S2006US.272 produced matchingly heaviest canes followed by S2006SP.30 and S2003US.718 which remained at par with each other. The minimum 100-cane weight of 78.33 kg has been recorded for S2006US.640. These results are in line to those of Aslam et al., (1998) and Nadeem et al., (2011) who have also reported significant varietal difference in individual cane weight.

Cane Density

Plant Population per unit area is a direct measure of final cane yield provided the individual cane weight remains the same. The final cane stand is the interaction of germination, tillering and tiller mortality. The data regarding the millable cane stand established by the tested genotypes presented
in table-1 explicate significant varietal differences in this regard. The variety S2006US.640 surpassed the tested genomes by producing 107.32 thousand millable canes per hectare which was non significantly followed by HSF.240 and S2006US.272 with 105.46 and 104.82 thousand cane stalks per hectare. The poor most final cane count of 89.54 thousand per hectare has been recorded for S2006US.641 preceded by S2006US.321 and S2006SP.30 which were, however, at par with one other. These differences in the final cane stand of tested varieties may be attributed to the differences in the germination and tillering. Aslam et al., (1998), Memon and Panhwar, 2004, Bashar et al., (2011) and Nadeem et al., (2011) have also recorded varied plant densities for sugarcane genotypes in their studies.

**Stripped Cane Yield**

The sole target of a sugarcane grower is to achieve the highest yield potential of a cane variety which is the outcome of the genetic potential of variety, the environmental factor and the management practices in combination. The number and size of millable canes per unit play a dominant role in determining the final cane yield. The data set out in table 1 evince that the promising sugarcane variety S2006US.272 magnificently out yielded the tested clones with a stripped cane yield of 104.07 t/ha. None of the varieties could compete it significantly . It was followed by HSF.240 and S2006US.321 which produced 93.15 and 91.98 tonnes stripped canes per hectare, respectively. The latter two were, however, at par with each other. The lowest cane yielder in the present study was S2006US.641 which produced 74.61 t/ha. It was preceded by S2006US.640. The highest cane yield produced by S2006US.272 may be attributed to the good germination, highest tillering, matchingly heaviest canes and the comparable cane density of promising variety. Measurable cane yield differences among sugarcane varieties have also been reported by Aslam et al., (1998), Memon and Panhwar, 2004, Afghan et al., (2010), Bashar et al., (2011), Nadeem et al., (2011) and Islam et al., (2013). 

**Sugar Yield**

The pivotal aim of all the research efforts being carried out on sugarcane is to improve the sugar yield per unit area which is the product of stripped cane yield and corresponding CCS. A perusal of the comparative data given in table 1 evince that only one sugarcane variety S2006US.272 crossed the check variety HSF-240 in sugar yield by producing 12.77 t/ha sugar against 11.25 t/ha of the check. The higher sugar yield produced by S2006US.272 is primarily due to its maximum cane yield and good CCS (12.28 %) in the present study. The differences among the cane varieties in the production of sugar per unit area has also been recorded by Aslam et al., (1998), Memon and Panhwar, 2004, Afghan et al., (2010), Bashar et al., (2011), Nadeem et al., (2011) and Islam et al., (2013). 

**Commercial Cane Sugar (CCS)**

CCS is the amount of actual sugar contents of a sugarcane variety and refers to the quality of cane. CCS of a variety holds prime importance as sugarcane is basically sown for sugar in our country. The data summarized in table 1 depict that the highest CCS of 12.35 % has been recorded for S2006US.54 which was closely followed by S2006US.272 and S2006US.718 with 12.28 and 12.35% CCS, respectively. These differences in CCS may be attributed to the genetic make up of the tested varieties. These results are in harmony with those elucidated by Aslam et al., (1998), Memon and Panhwar, 2004, Afghan et al., (2010), Bashar et al., (2011), Nadeem et al., (2011) and Islam et al., (2013).
Table 1: Biometric Traits of Elite Sugarcane Clones Under Semi Arid Conditions

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Variety</th>
<th>Germination</th>
<th>Tillers/Plant</th>
<th>100-Cane Weight (Kg)</th>
<th>Cane Density 000/ha</th>
<th>Cane Yield t/ha</th>
<th>CCS%</th>
<th>Sugar Yield t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S2006SP.30</td>
<td>47.85a</td>
<td>1.95bc</td>
<td>90.33b</td>
<td>93.85c</td>
<td>84.77c</td>
<td>11.89</td>
<td>10.07bc</td>
</tr>
<tr>
<td>2</td>
<td>S2006US.272</td>
<td>45.42ab</td>
<td>2.55a</td>
<td>99.33a</td>
<td>104.82ab</td>
<td>104.07a</td>
<td>12.28</td>
<td>12.77a</td>
</tr>
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<td>3</td>
<td>S2006US.321</td>
<td>38.54bcd</td>
<td>2.32ab</td>
<td>100.67a</td>
<td>91.37c</td>
<td>91.98b</td>
<td>11.89</td>
<td>10.94ab</td>
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<td>47.71a</td>
<td>2.11abc</td>
<td>78.33f</td>
<td>107.32a</td>
<td>83.98c</td>
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<td>5</td>
<td>S2006US.641</td>
<td>35.82cd</td>
<td>1.70c</td>
<td>83.33d</td>
<td>89.54c</td>
<td>74.61d</td>
<td>11.23</td>
<td>8.37c</td>
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<tr>
<td>6</td>
<td>S2005US.54</td>
<td>46.95ab</td>
<td>1.84bc</td>
<td>86.67cd</td>
<td>104.07ab</td>
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<td>11.12ab</td>
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<td>42.71abc</td>
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<td>12.23</td>
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<td>8</td>
<td>HSF.240</td>
<td>33.96ab</td>
<td>2.48a</td>
<td>88.33bc</td>
<td>105.46ab</td>
<td>93.15b</td>
<td>12.08</td>
<td>11.25ab</td>
</tr>
</tbody>
</table>

LSD 8.67 0.48 3.45 4.81 4.07 N.S 1.94

Values with different letter(s) differ significantly (P=0.05)

Fig 1: Germination, Tillering and cane weight of different cane Varieties

Fig 2: Cane density, Cane yield and Sugar yield of different cane Varieties
LITERATURE CITED


زباییکه‌شاخی‌های گیاه‌زی دانه‌های زرداییژن به‌بزرگ‌پی‌داور

زمین‌های تک‌فناک که به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمیته‌ها می‌توانند به‌صورت تکراری به‌طور مداوم می‌باشند، نیاز به کمیته‌هایی دارند که کمک به افزایش عملکرد انجام دهند. این کمی‌
EFFICACY OF DIFFERENT POST-EMERGENCE CHEMICAL APPLICATION FOR SUMMER WEEDS MANAGEMENT IN SUGARCANE

Muhammad Asad Farooq1, Karar Haider 2, Sagheer Ahmad1 and Muhammad Zubair1 and Shahid Afghan3.
1 Sugar Crops Research Program, Crop Sciences Institute, National Agricultural Research Centre, Islamabad.  2 Department of Agronomy, Gomal University, D.I. Khan, KPK. 3 Shakarganj Sugar Research Institute, Shakarganj Mills, Toba Road, Jhang

Abstract

Six different chemicals were evaluated for their efficacy in managing summer weeds of sugarcane belonging three different categories i.e. broad leaved, narrow leaved (grasses) and narrow leaved (sedges). These chemicals were used as solo applications as well as in combinations. Eleven different treatments were designed for this study including weedy check. The results revealed that the best control of all three types of weeds was achieved by two treatments i.e. Orcus+ Ametryn+Atrazine and Orcus+Dual Gold controlling more than 90% of weed flora in target fields without any negative effect on cane crop. The plots where Ametryn+Atrazine and Dual Gold were applied as solo, most of the broad leaved weeds and grasses were controlled but sedges remained uncontrolled. Hyver, Commit and Acetochlor achieved a moderate control of both broad and narrow leaved weeds. Where, Orcus was applied as solo, only sedges were effectively controlled. This study suggests that Orcus+ Ametryn+Atrazine and Orcus+Dual Gold may be the best combinations for chemical of all three types of weeds in sugarcane.

INTRODUCTION

Sugarcane (Saccharum officinarum L.) is a major sugar crop of Pakistan. It is next to cotton as a cash crop and plays a vital role in national economy as its share in value addition to agriculture and GDP is 3.2 and 0.7 percent, respectively. Sugarcane crop was cultivated on an area of 1124 thousand hectares, 6.2 percent more than last year’s area of 1058 thousand hectares. The production of sugarcane for the year 2012-13 is reported at 62.5 million tonnes, against the target 59 millions tonnes set for 2012-13 shows a healthy performance of 5.9 percent and to compare last year which was 58.4 million tonnes, depicts an increase of 7.0 percent (Anonymous, 2013). In Pakistan, average yield of sugarcane is much lower than that of world average, which is 75.89tha-1 (FAOSTAT, 2012). The reasons for low yield include conventional planting methods, costly inputs, heavy weed infestation, improper land preparation, less than recommended seed rate, imbalanced fertilizer application, shortage of irrigation water, illiteracy, less support price, lack of coordination between growers and mill owners, natural calamities, delayed harvesting, attack of insect, pests and diseases, poor management of ratoon crop and salinity.
Among these weed infestation is a major cause of low sugarcane yield (Hussain and Afghan, 2001; Baloch et al., 2002, and Malik and Gurmani, 2005). Being a long duration crop yield potential of sugarcane crop is affected more than 20-25% due to weeds (Khan et al., 2004a). Weeds compete with crop plants for nutrients, moisture, light, CO₂, space and release all elo chemicals. Weeds compete throughout the life cycle of main crop but it is more sensitive to presence of weeds at a specific period during its life cycle. It is known as critical period of weed crop competition. During this period weeds cause maximum yield losses. Critical period of weed-crop competition in sugarcane ranged between 27 and 50 days (Srivastava et al., 2003). Weed-crop competition of 3, 6, and 9 weeks after planting reduces 77.6%, 50.6%, and 41.7% yield of sugarcane, respectively (Zimdahl, 1980). After estimation of critical period of weed crop competition, weed control is very essential to harvest maximum yield. Weeds can be controlled manually, mechanically, biologically and chemically. Manual weeds control is laborious, time consuming and expensive than chemical weed control. Mechanical weed control may damage crop plants. Chemical weed control by herbicides is relatively efficient and economical. The effectiveness and relatively low cost of herbicides has resulted in management systems which are reliant upon their continued availability, and has led to almost a total exclusion of non-herbicidal methods of weed control (Little et al., 2006). Herbicides have little effect on crop growth in comparison with the effects of competition from weeds. They may cause some damage to sugarcane so they must be evaluated for their effects on crop and weeds before giving recommendation for their use (Turner et al., 1990).

MATERIALS AND METHODS
The experiment was conducted on September, 2012 planted sugarcane variety HSF-240 at research field of Sugar Crops Research Program, National Agricultural Research Centre, Islamabad, Pakistan during May-June, 2013. Observations on weed population were recorded with a quadrate of m², thrown thrice in a plot at random and species wise weed count was recorded and then averaged. Six different chemicals (Table-1) were evaluated for their efficacy for controlling five different summer weeds belonging three different categories i.e. broad leaved, narrow leaved (grasses) and narrow leaved (sedges) prevailing in the subject plots before application of treatments (Table-2). Eleven different treatments (Table-3) were designed for this study. Chemicals were used as solo applications as well as in combinations. Final weed count was recorded 4 weeks after application of treatments. Data was averaged, and percent weed population control (PWPC) was recorded using following formula;

\[\text{Percent weed population control} = 100 - \left(\frac{\text{PostTWP}}{\text{PreTWP}} \times 100\right)\]

Where;

PostTWP: Post treatment weeds population
PreTWP: Pre treatment weeds population
RESULTS AND DISCUSSION

Data regarding weed population revealed that the best treatment for weed control was Orcus + Dual gold, controlling 91.71% of overall weed population. This treatment was followed by Orcus + ametryn/atrazine (90.73%) and ametryn/atrazine + Dual Gold (68.90%). Hyver was found least effective against most of the weeds and weed population increased by 4.55%. Weed population in untreated weedy check increased by 15.73% over 4 weeks of experiment duration (Fig. 1). The best control of *D. muricata* L. was given by ametryn/atrazine + Dual Gold (92.50%) followed by Orcus + ametryn/atrazine (91.67%). The least effective treatment against *D. muricata* L. was offered by Orcus where population of *D. muricata* L. increased by 6.67% over 4 weeks of experiment duration. Weedy check resulted in 12.5% more population of *D. muricata* L. over 4 weeks of experiment duration (Fig. 2). The best control of *T. terrestris* was given by ametryn/atrazine + Dual Gold (98.00%) followed by Orcus + Dual Gold (97.50%). The least effective treatment against *T. terrestris* was offered by Orcus where population of *T. terrestris* increased by 7.67% over 4 weeks of experiment duration. Weed check resulted in 75.0% more population of *T. terrestris* L. over 4 weeks of experiment duration (Fig. 3). The best control of *E. colona* was given by Orcus + ametryn/atrazine (88.61 %) followed by Orcus + Dual Gold (88.31%). The least effective treatment against *E. colona* was offered by Acetochlor where population of *E. colona* increased by 6.12% over 4 weeks of experiment duration. Weedy check resulted in 11.70% more population of *E. colona* over 4 weeks of experiment duration (Fig. 4). The best control of *C. rotundus* was given by Orcus + Dual Gold (92.86%) followed by Orcus + ametryn/atrazine (92.45 %). The least effective treatment against *C. rotundus* was offered by Hyver where population of *C. rotundus* increased by 16.67% over 4 weeks of experiment duration. Weedy check resulted in 25.81% more population of *C. rotundus* over 4 weeks of experiment duration. It was noted that *C. rotundus* was effectively controlled only by Orcus whether alone or in tank mix with ametryn/atrazine and Dual Gold, tolerating the most of the treatments. The results are in confirmation with those of Webster and Coble (1997) who reported that *C. rotundus* was relatively tolerant to many herbicides used in agronomic crops (Fig. 5). The best control of *E. granulata* was given by Orcus + Dual Gold (88.33%) followed by Acetochlore (88.00%). The least effective treatment against *E. granulata* was offered by Orcus where population of *E. granulata* increased by 5.0% over 4 weeks of experiment duration. Weed check resulted in 40.0% more population of *E. granulata* over 4 weeks of experiment duration (Fig. 6). The best control of *T. portulacastrum* was given by Orcus + ametryn/ atrazine (98.33%) followed by Acetochlore + ametryn/ atrazine (97.50%). The least effective treatment against *T. portulacastrum* was offered by Hyver where population of *T. portulacastrum* - by 22.5% over 4 weeks of experiment duration. Weed check resulted in 42.0% more population of *T. portulacastrum* over 4 weeks of experiment duration (Fig. 7).
Fig. 1: Effect of different post-emergence chemical applications on total weed density

Fig. 2: Effect of different post-emergence chemical applications on D. muricata

Fig. 3: Effect of different post-emergence chemical applications on T. terrestris

Fig. 4: Effect of different post-emergence chemical applications on E. colona

Fig. 5: Effect of different post-emergence chemical applications on C. rotundus

Fig. 6: Effect of different post-emergence chemical applications on E. granulate

Fig. 7: Effect of different post-emergence chemical applications on T. portulacastrum

Table-1: List of chemical herbicides and their doses per acre used for weed control

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Herbicides</th>
<th>Active Ingredients</th>
<th>Dose/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ametryn + Atrazine (Target)</td>
<td>Ametryn + Atrazine</td>
<td>1000 g</td>
</tr>
<tr>
<td>2</td>
<td>Acetochlor (Jullundur Pvt. Ltd.)</td>
<td>Acetochlor</td>
<td>500 ml</td>
</tr>
<tr>
<td>3</td>
<td>Hyver (KanzoAg)</td>
<td>Nicsulfuron</td>
<td>30 g</td>
</tr>
<tr>
<td>4</td>
<td>Commit (KanzoAg)</td>
<td>Dicamba</td>
<td>300 ml</td>
</tr>
<tr>
<td>5</td>
<td>Orcus (KanzoAg)</td>
<td>Halosulfuron Methyle</td>
<td>20 g</td>
</tr>
<tr>
<td>6</td>
<td>Dual Gold (Syngenta)</td>
<td>S-Metolachlor</td>
<td>1000 ml</td>
</tr>
</tbody>
</table>
Table-2: List of target weeds species with technical, local and common names

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Scientific Name</th>
<th>Local Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cyperus rotundus L.</td>
<td>Deela</td>
<td>Nut Grass</td>
</tr>
<tr>
<td>2</td>
<td>Digera muricata L.</td>
<td>Tandla</td>
<td>False Amaranth</td>
</tr>
<tr>
<td>3</td>
<td>Echinochloa colona L.</td>
<td>Sawanki</td>
<td>Barnyard Grass</td>
</tr>
<tr>
<td>4</td>
<td>Euphorbia granulata Forror.</td>
<td>Hazardani Dodhak</td>
<td>Trailing Spurge</td>
</tr>
<tr>
<td>5</td>
<td>Trianthema portulacastrum</td>
<td>It Sit</td>
<td>Pigweed</td>
</tr>
<tr>
<td>6</td>
<td>Tribulus terrestris</td>
<td>Bhakra</td>
<td>Caltrop</td>
</tr>
</tbody>
</table>

Table-3: List of target weeds species with technical, local and common names

<table>
<thead>
<tr>
<th>Treatment No.</th>
<th>Herbicides</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Orcus</td>
</tr>
<tr>
<td>T2</td>
<td>Hyver</td>
</tr>
<tr>
<td>T3</td>
<td>Commit</td>
</tr>
<tr>
<td>T4</td>
<td>Acetochlor</td>
</tr>
<tr>
<td>T5</td>
<td>Dual Gold</td>
</tr>
<tr>
<td>T6</td>
<td>Ametryn/Atrazine</td>
</tr>
<tr>
<td>T7</td>
<td>Orcus + Ametryn/Atrazine</td>
</tr>
<tr>
<td>T8</td>
<td>Orcus + Dual Gold</td>
</tr>
<tr>
<td>T9</td>
<td>Ametryn/Atrazine + Dual Gold</td>
</tr>
<tr>
<td>T10</td>
<td>Acetochlor + Ametryn/Atrazine</td>
</tr>
<tr>
<td>T11</td>
<td>Weedy Check</td>
</tr>
</tbody>
</table>

REFERENCES

TECHNICAL BRIEF ON GUR PRODUCTION FROM SUGARCANE

Practical Action, The Schumachar Center for Technology and Development, UK

The yield of gur from sugar cane depends mostly on the quality of the cane and the efficiency of the extraction of juice. The table below gives some extreme values.

<table>
<thead>
<tr>
<th>Description</th>
<th>High quality cane</th>
<th>Poor quality cane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juice per 100 kg of cane</td>
<td>50 kg</td>
<td>40 kg</td>
</tr>
<tr>
<td>% sugar in juice</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>Gur per 100 kg of cane</td>
<td>10 kg</td>
<td>7 kg</td>
</tr>
</tbody>
</table>

High quality cane has a good juice content with high sugar levels (20 %+). Poor quality cane or cane that has been harvested early may have similar juice content but the sugar levels will be reduced.

The efficiency with which juice can be extracted from the cane is limited by the technology used. The simple three roller crushers used by most artisanal producers will never extract more than 50 kg of juice from each 100 kg of cane.

Yields are also improved by careful control of the boiling process. Boiling should be completed as rapidly as possible and the conditions kept as clean as possible.

Crushing

Most artisanal sugar producers use a simple crusher consisting of three metal rollers. This is driven by either animal or diesel power. Figures 1 and 2 show both types in operation in Bangladesh. A crusher driven by a single ox can be expected to process around 50kg of cane per hour. A 5HP diesel set could increase this to around 300kg per hour. In these pictures the rollers are set vertically; many machines have horizontal rollers. Suppliers of this machinery are given at the end of this technical brief.

Figure 1: Animal powered crusher
Important points to remember during crushing are:

- Cane must be crushed within 24 hours of being cut. After this time the sugar begins to ‘invert’ into different sugars that will not set solid.
- Crushing efficiency is the most important factor in good sugar yields. Every possible amount of juice needs to be squeezed from the cane.

**Juice treatment**

Juice should be filtered through a cloth before boiling in order to remove any solids such as dirt or particles of cane. Large-scale sugar processors add lime to the juice in order to coagulate impurities which then settle out. (This is rarely done at the artisanal level.) The juice is then neutralised with sulphur dioxide. Small-scale producers add a variety of clarificants to the juice including wood ash. All of these have the effect of settling out impurities. Many producers also add ‘Hydros’ (sodium hydrogen sulphate) at the final stages of boiling. This releases sulphur dioxide into the juice and lightens the colour of the final product. (Note that high sulphur content often remains in the final product.)

![Figure 2: A Diesel powered cane crusher with three vertical rollers](image)

**Juice boiling**

This is done in large pans over open fires or simple furnaces (see figure 3). The essential requirement is for clean pans and tools. Sediment settles to the bottom of the pan during boiling and is dredged out. Scum rises to the top and is skimmed off. (Both of these wastes can be fed to cattle.) A large pan such as that pictured in figure 3 would hold about 100 kg of juice reducing to around 20 kg of gur. The pans are usually made from galvanised mild steel sheets.

The end point of the boiling process is judged from experience; from the sight and sound of the boiling juice. Small samples can be removed to see if they set solid when cooled. For those with access to simple sugar measuring devices, this usually corresponds to a Brix (sugar content) of 90-95%.
After removal from the heat, the pans of juice are usually stirred rapidly to incorporate air and promote an even crystallisation. The cooling juice is then poured into pots or moulds to set.

**Cleanliness**

Cleanliness is vital to the whole process. Once the juice has been heated, impurities will speed the 'inversion' of sugar and lead to reduced yields. All boiling pans and tools need to be thoroughly cleaned between uses.

![Figure 3: A simple open pan used for processing the juice extracted from the sugar cane](image)

**Tools**

The tools required are very simple. Filtration before boiling is done through a fine woven cloth. Scum is removed from the boiling juice by a simple perforated scoop on a long handle. Sediment is removed by scraping a stretched cloth along the bottom of the pan. Once the pan has been removed from the heat, a simple rake is used to stir the thickened juice.

**Mass balance**

For the technically minded, the weights of the gur, juice and cane can be related as follows:

\[
\text{Weight of gur} = \frac{\text{Weight of cane} \times \frac{\text{weight of juice}}{\text{weight of cane}} \times \frac{\text{sugar in juice}}{\text{sugar in gur}}}{\text{weight of cane}}
\]

Typical figures would be:

\[
10 \text{ kg gur} = 100 \text{ kg cane} \times \frac{50 \text{ kg juice}}{100 \text{ kg cane}} \times \frac{19 \% \text{sugar in juice}}{95 \% \text{sugar in gur}}
\]
Simulating the impact of trash management on Brazilian sugarcane cropping systems
F.R. Marin, L.G. Costa and P.J. Thorburn

Historically, trash has been burnt in Brazil. However, increasingly crops are being harvested green with trash retailed as blanket (GCTB) due to environmental restrictions. Currently, there is interest in using trash as a feedstock for bioenergy. The presence of a trash blanket affects sugarcane crops, by conservation of soil moisture and a potential to increase soil carbon (C) and nitrogen (N). To gain insights into the impacts of the burnt-to-green cane trash blanket transition and trash management on sugarcane production in Brazil, a simulation study was conducted with the APSIM-Sugar farming systems model. Simulations were conducted over 100 years for three locations around Brazil: Piracicaba-SP, Palmas-TO, and Maceió-AL, addressing two research questions: 1) what is the yield impact of the transition from burnt to GCTB due to soil N, C and water changes; and 2) what is the impact of trash removal on yield in fields managed under GCTBs. Both questions were answered based on the same set of simulations. We simulated the transition to GCTB after 25 years of burnt management combining four nitrogen application rates (50, 100, 150 and 200 kg/ha). The second goal was addressed by setting up three simulation treatments (100% trash retention, 50% trash removal and 90% trash removal) under the same N fertiliser rates. The simulation study showed that sugarcane yields have potential to respond positively to trash retention, and stalk yield for 50% and 90% trash removal treatments decreased at rates proportional to the trash extraction rate only in Piracicaba. In Palmas, located in a dryer region, simulations showed trash retention having positive effects on soil water retention besides the benefits from higher N availability. This study also illustrates the potential negative, short-term impact of trash blanketing on sugarcane yields due to immobilisation of N as soil organic matter increases in response to trash inputs. While this effect will diminish through time, there may be some N shortage for the crop during this transition from burnt to GCTB management and more information on N fertiliser management during this transition would be useful.

Functional relationships between dry above-ground biomass and the energy yield of sugarcane
J.L. Chopart, L. Bonnal, J.F. Martine and D. Sabatier

Two studies conducted in Guadeloupe (West Indies) and Réunion (Indian Ocean) islands were designed to investigate the benefits of producing sugarcane as an energy crop and to assess the influence of agroclimatic factors on energy efficiency, respectively. In this context, it is essential to know the low heating value of the dry above-ground biomass (LHVD, MJ/kg) and its energy yield (EY, MJ/m2) in order to select the best varieties and set up a payment method for growers. Eighteen Poaceae (sugarcane and Erianthus) cultivars were compared under wet tropical environmental conditions in Guadeloupe. Three sugarcane cultivars were studied in four contrasting environments in Réunion. The partition sampling and biomass measurement procedures were identical at both locations. Low heating value (LHV) predictions were achieved using near-infrared reflectance spectroscopy (NIRS) after specific calibration (Guadeloupe), or arithmetically after lignocellulosic compound prediction (Réunion). In both studies, LHV variability was very low and slightly dependent on the site, cultivar and above-ground biomass components (millable stalks and tops, and green and dead leaves). Considering the overall dry above-ground biomass (DAB, kg/m2), the LHVD was calculated by averaging 159 samples (mean 16.65 MJ/kg) in Guadeloupe and 315 samples (mean 16.45 MJ/kg) for Réunion. An excellent linear relationship between the DAB and its LHVD, regardless of cultivar, age and environment, was found (n = 474 and R2 = 0.99). Sugarcane energy content assessment could thus be simplified by measuring the DAB, while enabling development of a faster method of payment for growers based on the DAB measurement and the correlation between DAB and EY. Finally, the findings of this study should allow growers to rapidly determine the commercial value of their sugarcane crops, and also enable purchasers to assess the amount of recoverable energy.
Effects of sugarcane residues on soil microbial biomass-carbon and sugarcane yield in a tropical ultisol

Sri Haryani, Heru Gunito and Norma Mulyani

Organic matter inputs restore and sustain soil fertility under intensive sugarcane cropping. Soil microbial biomass-carbon (SMBC) is an indicator used for assessing the effect of soil amelioration, particularly organic matter addition. An experiment was conducted to study the effectiveness of different sugarcane organic residues at different rates to sustain SMBC and improve sugarcane yield on a tropical Ultisol in Gunung Madu sugar plantation, Lampung, Indonesia. The organic inputs were 5:3:1 mixtures of bagasse, filter-cake, and boiler ash (BFA) in composted and raw form (BFA-compost and BFA-raw), and raw bagasse alone (RB), with C:N ratios of approximately 25:1, 35:1, and > 75:1, respectively. The study was conducted as both pot and field trials, wherein 0–400 t/ha rates of application were tested. Field trial results showed that the annual mean of SMBC in RB treatments was 39.28 mg/kg, whereas in BFA-compost and BFA-raw SMBC, means were 26.70 and 33.39 mg/kg, respectively. Based on rates of application, the highest SMBC of 48.55 mg/kg (114.34% >control or zero application) corresponded to the highest rate of application (400 t/ha). Meanwhile, sugarcane yields averaged 92.2, 99.8, 106.3, 117.0, and 120.3 t/ha at 0, 50, 100, 200, and 400 t/ha application, respectively, indicating a positive yield response to application of sugarcane residues. Average sugarcane yields were 101.2, 100.2, and 120.0 t/ha for BFA-compost, BFA-raw, and RB, respectively. These results indicate that application of RB alone, despite its high C:N ratio, could improve SMBC and sugarcane yield, comparable to BFA-compost and BFA-raw. All these bulk organic inputs, however, contributed only short-term improvement (less than one year) of SMBC under this particular Ultisol and the local sugarcane cropping system. Regular application of RB at 50 t/ha may be considered at a commercial scale.
Trinexapac-ethyl: will it increase early season sugar accumulation?
A.J. Orgeron, J.L. Griffin1, B.L. Legendre, K.A. Gravois, D.K. Miller and M.J. Pontif

Utilization of synthetic ripeners to improve early season stalk sucrose concentration has become a normal
management practice for many sugarcane producers in Louisiana. This study evaluated the effect of synthetic
ripeners, trinexapac-ethyl and glyphosate, on five commercial Louisiana sugarcane cultivars. The randomised
complete block design included five cultivars (HoCP 96-540, L 99-226, L 99-233, HoCP 00-950, L 01- 283) and
four ripener applications [none, glyphosate (210 g ae/ha), and trinexapac-ethyl (300 and 350 g ai/ha)]. Yield of
theoretical recoverable sugar per tonne of sugarcane (TRS) at eight weeks after glyphosate application increased from
9.5% (L 01-283) to 27.7% (L99-226) compared to their nontreated controls. In contrast, trinexapac-ethyl at 350 g/ha
increased TRS from 7.2% (HoCP 00-950) to 10.2% (L 99-233). Averaged across cultivars, TRS was increased 17.5%
with glyphosate compared to 9.7% for the high rate of trinexapac-ethyl. Averaged across cultivars, yield of tonnes
cane per hectare (TC/H) did not differ significantly across glyphosate and trinexapac-ethyl treatments, but averaged
7.3% less than the nontreated control. A cultivar by ripener treatment interaction was not observed for the yield of
theoretical recoverable sugar per hectare (TRS/H). TRS/H was increased by glyphosate for only one cultivar, HoCP
96-540 (15.7%) and by the low rate of trinexapac-ethyl for only one cultivar, L 01-283 (3.2%). When averaged
across cultivars, TRS/H was increased 7.4% for glyphosate but no increase was observed for either rate of trinexapac-
ethyl. In conclusion, both glyphosate and the high rate of trinexapac-ethyl effectively increased TRS of all cultivars
above their nontreated controls. Although the high rate of trinexapac-ethyl improved TRS, the response was less than
for glyphosate. Glyphosate and both rates of trinexapac-ethyl decreased TC/H below their nontreated controls.
Although an equal reduction in TC/H was observed for both glyphosate and trinexapac-ethyl, glyphosate application
led to greater improvements in TRS/H. When considering only TRS/H, results of this study bring into question the
value of using trinexapac-ethyl as a ripener to improve early-season sugar accumulation for the Louisiana sugarcane
industry.

Dynamics of sugarcane harvest residue decomposition in Argentina

The aim of this paper was to evaluate the dynamics of sugarcane residue decomposition and to study nutrient release
from residue. The trial was conducted in Tucumán-Argentina from 2008 to 2012. The sugarcane cultivars used were
LCP 85-384 and RA 87-3. Every 25–35 days we evaluated: 1) residue fresh and dry weight and 2) residue C/N ratios.
At the beginning and end of each cycle, we evaluated residue P and K content. LCP 85-384 initial residue amounts
ranged from 11.6 t/ha to 15.2 t/ha, whereas decomposition rates were between 43% and 59%. RA-87-3 initial residue
amounts ranged from 12.5 t/ha to 18.1 t/ha, with decomposition rates between 36% and 60%. Fresh residue C/N ratios
were over 60. The highest initial C/N ratios were 79.2 (in 2008/09) and 102.9 (in 2009/10) for LCP 85-384 and RA
87-3, respectively. At the end of each crop cycle, trash C/N ratios dropped significantly. Residue initial C
concentration was between 42%–45.5% and 38.8%–47.5% for LCP 85-384 and RA 87- 3, respectively. Residue initial N
ccentration ranged from 0.53%–0.71% and 0.43%–0.66% for LCP 85-384 and RA 87-3, respectively. Residue final C
concentration decreased and residue final N concentration increased, resulting in lower C/N ratios. Residue initial K concentrations ranged from 0.64%–0.75% for LCP 85-384 and 0.56%–0.67% for RA 87-3. At the end of each crop cycle, K release values were high. In conclusion, although the amount of residue left in the field was high after sugarcane harvest, we observed that the decomposition rate increased through the crop cycle. This residue
decomposition supplies the agroeco system with varying amounts of C, N and K, which may help meet fertilisation
needs in the medium term.
Case study: preserving the use of diuron for sugarcane production in catchments adjacent to the great barrier reef
M.J. Kealley and B.J. Milford

Diuron is an important residual herbicide for effective weed management in the Queensland sugarcane industry; however, its continued use is dependent on a review of environmental risk by the Australian Pesticide & Veterinary Medicines Authority (APVMA). Against the backdrop of the Great Barrier Reef, CANEGROWERS Australia was concerned the loss or reduction of diuron rates and a no-use period during the wet season would create an adverse outcome to both the production system and environment. This paper is an account of the management activities undertaken by CANEGROWERS, a grower organisation, to attempt to ensure appropriate science was applied to the decision. CANEGROWERS undertook an analysis of the science, diuron usage rates and climate variability of Queensland to provide counterargument to the APVMA’s findings that diuron posed an unacceptable risk to water quality from runoff during the wet season. CANEGROWERS worked with an independent scientific expert and two chemical companies to critique the APVMA’s modelling methodology. A survey of growers was conducted to determine industry usage rates, application methods and practices to support risk mitigation through industry best practices. A climatologist was engaged to review the climate variability data of Queensland cane growing regions to determine how Pacific Ocean El Niño–Southern Oscillation (ENSO) affects no-use periods based on a calendar year. The modelling review identified the APVMA’s assessment was excessively protective. The grower survey results supported an industry best practice rate of 1.8 kg active constituent (ac) per ha per year. The survey also identified a wide range of best practices and that diuron was central to weed management. The review of the climate variability in Queensland identified significant differences in wet season start and finish dates directly attributable to El Niño-Southern Oscillation. This suggested the no-use period for diuron application was not the optimal strategy for long-term sustainability. The review reinforced the complexity of cane growing across Queensland, the uptake of best practice and the support of diuron. Alternative modelling data and outcomes were provided to the APVMA. Their decision to amend label and use conditions was made in November 2012.

Effect of trash management on nitrogen dynamics and yield: modelling long-term experimental results of sugarcane in Brazilian coastal tablelands
Ana Paula Pessim De Oliveira, Peter J. Thorburn, Jody S. Biggs, Eduardo Lima, Lúcia Helena Cunha Dos Anjos and Marcos Gervasio Pereira

To evaluate the impacts of trash management on sugarcane production in Brazil, including the long-term fate of N contained in trash and the N fertiliser management implications of trash retention, a simulation study was conducted with the APSIM- Sugar cropping systems model. Simulations were conducted over the past 14 years with data from an experiment in the municipality of Linhares-ES. The trash management systems simulated were (1) Green Cane Harvesting and Trash Blanketing (GCTB), (2) half GCTB, and (3) burnt trash. N fertiliser management systems were simulated by varying N fertiliser application with rates from 0 to 240 kg/ha (in 40 kg/ha increments) on the ratoon crops. Cane yields from the experiment were simulated well by the model with Root Mean Square Errors between predicted and measured values of 14.02 t/ha and 13.45 t/ha for the for the burnt and GCTB treatments, respectively. The simulation study showed that cane yield responded positively to the GCTB and half GCTB systems, but the magnitude of the response was dependent on N-fertiliser applied to crops. The removal of half the trash reduced yield potential in sugarcane. Additional N fertiliser was required following recent trash deposition to avoid yield reduction caused by N immobilisation. Implications of this disequilibrium period on the results of short-term trash management trials and the transition from trash burning to conserving systems are discussed. The simulations also indicate that average environmental losses of N are likely to be greater from GCTB systems at all rates of N fertiliser applications due to higher SOM concentration which may result in higher soil mineralisation rates and greater nitrate release to soil solution conditions which are favourable for N loss. Thus, particular care should be taken to avoid excessive application of N fertiliser.
Frost severity effect on sprouting and seedling emergence of high quality seed cane in Tucuman, Argentina
J.A. Giardina, P.A. Digonzelli, E.R. Romero and D. Duarte

In Tucumán, Argentina, low temperatures affect most of the sugarcane production area, and plantations suffer the effects of both light and very severe frosts. The impact of frost severity on seed cane sprouting capacity was studied under lab and field conditions. In both studies, a completely randomised design with three replicates was adopted. Samples from three sugarcane varieties were used (LCP 85-384, RA 87-3 and TUCCP 77-2) from different sites where freezes of varying intensity (mild, moderate and very severe) had occurred. Germination under optimal conditions was evaluated in the lab, using uninodal stalk segments placed on trays (45 segments per tray) under controlled humidity at a temperature of 25 oC. Concurrently, emergence dynamics were evaluated in the field. Planting materials were sown in wide-bottom furrows, with a 15 to 20 buds/metre density, and kept under an average temperature of 22 oC without irrigation. Results showed that, under mild frost conditions, the low temperatures did not significantly affect the buds of the three varieties and sprouting percentages of 84% for RA 87-3 and 73% for the two other varieties were recorded. In the field, emergence percentages were 70%, 66% and 57%, for RA 87-3, TUCCP 77-42 and LCP 85-384, respectively. After moderate frosts, buds of RA 87-3 showed higher susceptibility, with only 14% and 19% emergence in the lab and field, respectively. In contrast, the other two varieties had similar emergence levels, with values ranging between 40% and 50%. With very severe frosts, the three varieties suffered significant damage, ranging from 0% to 7% emergence in the lab and field. While frost severity produced significant varietal differences in the sprouting percentages, the emergence dynamics of the three varieties tested were not significantly modified by mild and moderate freezes and responded to a simple exponential model.
good milk is a naturally nutritious complete meal. Global Food Guide recommends daily consumption of milk. Whether hot or cold, with coffee or with tea, as a milkshake or on its own, enjoy your good milk daily - it’s the best choice.

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INTERNATIONAL EVENTS CALENDAR

**May 18-21**
Sugar Industry Technologists Meeting, Toronto, Canada [www.sucrose.com](http://www.sucrose.com)

**June 2-3 & 16-17**
McGinnis Institute of Beet Sugar Technology (MIBST), Beet Process School (beet end), Denver, Colorado State, USA [aimee@bsdf-assbt.org](mailto:aimee@bsdf-assbt.org)

**June 18-20**
Joint Florida & Louisiana Division ASSCT (The American Society of Sugar Cane Technologists), Bonita Springs, Florida, USA [www.assct.org](http://www.assct.org)

**June 23 – July 13**
Raw Cane Sugar Manufactures’ Institute, Nicholls State University, Thibodaux, LA USA [mccurry@nicholls.edu](mailto:mccurry@nicholls.edu)

**July 1-3**
74th 11RB (Robert Benjamin) Congress, Dresden, Germany [aimee@bsdassbt.org](mailto:aimee@bsdassbt.org)

**July 21-August 01**
Cane Sugar Refiners’ Institute, Nicholls State University, Thibodaux, LA USA

**August 1-6**
74th 11RB (Robert Benjamin) Congress, Dresden, Germany [www.sugaralliance.org/symposium](http://www.sugaralliance.org/symposium)

**August 20-22**
87th SASTA Congress, Pietermaritzburg, South Africa

**August 26-29**
FENASUCRO (International Fair of Sugar cane Industry), Sertãozinho, S.P (Sao Paulo), Brazil [www.fenasucro.com.br](http://www.fenasucro.com.br)

**August 31-September 03**
Sugar Processing Research Institute Conference, Sertãozinho, S.P (Sao Paulo), Brazil [www.sprinc.org](http://www.sprinc.org)

**September 3-5**
ICUMSA (International Commission for Uniform Methods of Sugar Analysis) Conference, Sertãozinho, S.P (Sao Paulo), Brazil

**September 4-5**
Latin American Cane Show, Playa Blanca, Panama

**October 19-24**
Latin American Sugar Technologist Meeting (ATALAC), Olinda, Pernambucco, Brazil
Launch of Expended Program of Immunization (EPI) Shabirabad Free Dispensary

Background

The Expended Program of Immunization (EPI) was launched in Pakistan in 1978. It aims at protecting children by immunizing them against Childhood Tuberculosis, Poliomyelitis, Diphtheria, Pertussis, Measles, Tetanus and also their mothers against Tetanus.

Purpose of the Program

The purpose of this program is to initiate a collective effort to reduce the mortality results from the seven (EPI) target diseases by immunizing children of the age 0-11 months and women of child bearing age. With the courtesy of District health Office Expended Program of Immunization has been started at our Stationed Free Dispensary SML Jhang on 09 May 2012. Adjacent areas of Shakarganj Mills Limited are being benefited through this activity.

In continuation of the same expended program of immunization launched ceremony was held at Shabirabad Free Dispensary on 12 March 2013. Dr. Khalid Islam Executive District Officer Health was the chief guest of the ceremony. Mr. Mohammad Pervez Akhtar Senior Executive

Vice President Shakarganj Mills Limited and Mr. Manzoor Malik Senior Vice President Agriculture were also present on the occasion. EDO Health deputed their vaccinator at Shabirabad Free Dispensary who will visit at 09th day of each month and vaccinates the infants and their mothers.

The chief guest visited the dispensary and vaccinated the infants, at the occasion Manager Social Action Program briefed the chief guest about the Social Action Health Care Program activities being carried out at 06 Kissan Markaz.
The chief guest Mr. Khalid Islam Executive District Officer Health appreciated the efforts of Shakarganj Foundation and promised to depute vaccinators of District Health Office at all Kissan Marakaz to ease the rural community who could not find it convenient to travel from far away areas to District Hospital Jhang to get vaccination for their infants.

He further assured to support the mandate of the Shakarganj Foundation by all the available resources of the District Health Department.
Sugar and Behaviour

Background

A high intake of sugar is widely assumed to cause hyperactivity and behavioural problems in both children and adults. However, the results of the majority of scientific studies do not support this belief. The most comprehensive meta-analysis on this subject to date was undertaken by Wolraich et al., (1995) which analysed the results of 16 studies examining the effects of sugar (mostly sucrose) on a variety of behavioural and cognitive measures. The studies had been undertaken on normal children, as well as children with Attention Deficit Hyperactivity Disorder (ADHD), and children whose behaviour was reportedly adversely affected by sugar. Subjects, parents and research staff were blinded to conditions in these studies. The review concluded that sugar did not affect the behaviour or cognitive performance of children, and suggested that beliefs and expectations can have a profound effect and override perception. However, the authors did note that they could not rule out a small effect of high sugar intake on subsets of children.

Since the definitive review by Wolraich et al., (1995) the role of sugar on behaviour has attracted little attention. However, more recently Benton (2008) reviewed the specific effects of sucrose in detail and examined the results of studies by: subgroup of children (ADHD and sugar reactors); children's age; the timing of the test in comparison to the sugar exposure; and placebo type. All yielded negative results with sucrose determined not to affect the behaviour of children.

Benton (2008) also reviewed the evidence supporting the 3 main hypotheses linking sucrose intake to behavioural problems, namely: sucrose intolerance (i.e. food allergy or hypersensitivity); hypoglycaemia; and micronutrient deficiency. With respect to sucrose intolerance, although there may be individual idiosyncratic cases of sucrose intolerance, the percentage of children who reportedly respond adversely (migraine or hyperactivity) to sucrose in elimination diets is much lower than for other foods which are commonly reported to cause migraine or hyperactivity. It is unlikely that sucrose causes hypoglycaemia since, in normal and obese individuals without diabetes, blood glucose is kept remarkably stable even when sucrose is provided within drinks between meals (Manders et al., 2009). Although some individuals may report symptoms with lower blood glucose levels (although not necessarily clinical hypoglycaemia (Simpson et al., 2006), it is unlikely that such symptoms would be attributable to sucrose, since sucrose has a moderate glycemic index of ~68 (Foster-Powell et al., 2002) and thus a lower insulin response than other highglycemic index foods. Finally, although evidence may exist for a role of inadequate micro-nutrient intake on behaviour, evidence is not conclusive regarding a high sugar intake and micronutrient inadequacy (see WSRO Position Statement – Sugar and Micronutrient Dilution).

Recommendations for sugar and behaviour

A number of organisations have assessed the relationship between sugar intake and behaviour. The Australian National Health and Medical Research Council found no evidence for the involvement of sugar or sugar-containing foods in attention deficit or hyperactivity disorders (NHMRC, 2003). The Institute of Medicine could not set up upper limit for sugars with respect to altered behavior (IOM, 2005). Finally, a joint FAO/WHO report concluded
that sugars do not affect behavior in children (FAO/WHO, 1997).

Statement
Despite evidence to the contrary, it is frequently asserted that sugar intake causes hyperactivity. The overriding evidence from scientific studies examining groups of children does not support adverse effects or sucrose intolerance. It is highly unlikely that sucrose would result in a reactive hypoglycemia due to its moderate glycemic index and lower insulin response. Although evidence does exist for a micronutrient dilution effect with a high sugar intake, micronutrient intake is usually adequate. Therefore it is highly unlikely that sugar intake per se has an effect on behavior via a low micronutrient intake.

References

Sugar and Dental Caries
Background
The World Oral Health Report (2003) reported a vast reduction in worldwide dental caries experience between 1980 and 2000. However, dental caries continues to be a major health problem, particularly in the developing world. Dental caries occur when acid-producing bacteria, especially Mutans streptococci, Lactobacilli and Actinomyces species, populate the sticky coating (plaque) on the surface of the tooth. These bacteria convert fermentable carbohydrates such as glucose, fructose, sucrose and maltose (which may be derived from hydrolysis of cooked starches by salivary amylase) into lactic acid, thus making plaque acidic. The acidic plaque causes demineralisation of the tooth enamel and, if unchecked, the underlying dentine. The presence of bacteria and fermentable carbohydrates are not the sole factors which can affect dental caries. Other factors include the innate susceptibility of tooth surfaces, frequency of eating, intrinsic properties of the foodstuff affecting food clearance, oral hygiene practices, fluoride availability, genetic factors, and salivary flow and composition. Saliva contains protective minerals (calcium) and buffers which aid in re-mineralisation of the tooth enamel and neutralisation of the acid environment. Saliva is also a reservoir for fluoride which exerts its protective effects by reducing the effectiveness of acidogenic bacteria or the susceptibility of enamel to acid dissolution. Under normal circumstances, the demineralisation that occurs following any eating occasion involving fermentable carbohydrates is repaired by the replacement of lost material with minerals from saliva. However, if the balance between demineralisation and repair favors
demineralisation, as a result of frequent consumption of carbohydrate substrates for these acidogenic bacteria, a focal area where the enamel structure becomes porous may result. This is called a "white spot lesion" and may repair spontaneously. If acid attack endures, without the natural repair process being able to correct demineralisation, then further loss of the tooth surface architecture may occur and result in bacterial invasion into the resulting cavity. At this stage spontaneous repair is unlikely and the cavity will require treatment to prevent further damage. The significance of sugar in influencing the dental caries process has been the subject of research and debate for more than 100 years.

A role for amount of sugar? Researchers have employed ecological studies in order to determine whether a relationship exists between sugar intake and prevalence of dental caries. Sreebny (1982) reported a significant linear relationship between sugar supply and dental caries prevalence in a cross-sectional study of 12-y old children across 47 countries. Sugar supply was estimated to explain approximately 50% of the variance in caries experience. However, there was no apparent relationship in 5-y old children. A later reexamination of the relationship, with a much larger data set, reduced the estimated proportion of the variance attributable to the amount of sugar in the food 2 supply by more than half (Woodward and Walker, 1994). Furthermore, examination of the data from only developed countries showed no relationship between sugar supply and caries. These findings suggest that, in both the developed and developing world, other factors are more important than sugar supply in determining caries experience. Sreebny (1982) proposed a cut-off of 50 g sugar per person per day to minimise risk of caries. This suggestion was taken into account by the WHO/FAO (2003) who proposed a similar cut-off of 6 – 10% energy as ‘free sugars’ (defined as all mono- and disaccharides added to foods, plus sugars naturally present in honey, syrups and fruit juices). This recommendation was made despite evidence to the contrary (Gustaffson et al., 1954, Ruxton et al., 1999, Woodward and Walker, 1994).

Although the relatively small reduction in caries experience during war-time rationing of sugar is consistent with a role for sugar supply in the caries process, the most substantial reduction in dental caries during the past 40 years has occurred following the introduction of fluoridated water or toothpaste and improved oral hygiene (Kandelman, 1997, Konig, 1990). Trends in caries reduction in industrialised countries have occurred not only independent of sugar intake, but also whilst sugar consumption has stayed relatively constant (Downer, 1994, Konig, 1990). Indeed, population data show no relationship between changes in sugar supply and changes in caries prevalence (Ruxton et al., 1999). Furthermore, the evidence does not support the proposition that even total removal of sugar (added, free or NMES) from the diet would eliminate caries (Konig, 1990, Woodward and Walker, 1994). This is explicable in the light of the evidence that all fermentable carbohydrate, including the staple food cooked starch, is acidogenic in the presence saliva and certain oral bacterial populations. The results of smaller longitudinal population and intervention studies have not indicated a strong relationship between sugar intake and caries incidence. A two year study on English school children reported a significant relationship between consumption of sugars and caries, although sugars consumption could only explain 2% of the variance in caries incidence (Rugg-Gunn et al., 1984). A 100% increase in sugar consumption in children, prior to modern oral health practices and ethical considerations, did not result in a significant effect on caries development (King, 1955). Furthermore, a 5-year
A role for frequency of sugar intake?
Frequent snacking of fermentable carbohydrates, particularly in the absence of adequate oral hygiene, may not allow time for sufficient buffering of the tooth environment or remineralisation via salivary action. In the absence of oral hygiene, the classic experiment of Gustafsson et al., (1954) showed that frequency of sugar consumption was far more important in influencing dental caries than amount. Duggal et al., (2001) showed that twice daily use of fluoride toothpaste increased the frequency with which a 12% sugar solution could be imbibed from 4 up to 7 times a day without significant enamel demineralisation. The authors speculated that tooth 3 brushing twice daily with fluoride toothpaste might allow fermentable carbohydrates to be consumed up to 5 times a day without increasing the risk of caries.

In contrast, Gibson and Williams (1999) reported frequency of consumption of all sugary foods (including soft drinks) was not associated with caries experience in preschool children regardless of reported tooth brushing frequency. However, in this study, an association of caries with consumption of sugar confectionery (both amount as % energy and frequency) was seen in children who brushed their teeth once a day or less. In addition to the confounding effects of oral hygiene, food clearance, bacterial and salivary levels, it is difficult to isolate the effect of frequency from amount in observational studies of populations as the two may be strongly correlated (Rugg-Gunn, 1993). However, a recent review of observational epidemiological studies reported a more significant relationship of frequency than quantity of sugar with dental caries (Anderson et al., 2009)

Intrinsic, extrinsic, added, free sugars and NMES?
Organisations frequently provide recommendations depending on whether the sugar is naturally found within a foodstuff or has been added in processing. Sugars may be defined as: ‘intrinsic' found naturally within the cell in unprocessed food, or ‘extrinsic' or ‘free' found outside of the cell. Extrinsic sugars comprise sugars naturally present in honey, syrups and fruit juices, as well as sugars added to foods at the table or in processing. Milk sugar (lactose), being natural, although an extrinsic sugar, is often considered a special case. Therefore, extrinsic sugars may be referred to as non-milk extrinsic sugars (NMES). The recommendations from certain agencies with regard to sugar intake and risk of dental caries are only for added, free or NMES sugars (DoH, 1989, WHO/FAO, 2003). However, the evidence does not support a differential effect of intrinsic versus extrinsic sugars (added, or free or NMES) with regard to acid production (Beighton et al., 2004) or enamel demineralisation (Issa et al., 2011). Indeed, an expert group convened by WHO and FAO specifically recommended that these terms should not be used as they are unhelpful and confusing (Cummings and Stephen, 2007).

Recommendations for sugar and dental caries risk
The advice regarding sugar and oral health is inconsistent. Sugar intake is still viewed by many agencies, including Australia (NHMRC, 2003) and the UK (DoH, 1989, 2005, 2009) as a prime, if not the main cause...
of dental caries. The latter organisation recommends for NMES not to exceed 11% of food energy, and for sugars to not be consumed more than 4 times a day. These recommendations approximate those of the WHO/FAO (2003), and are inconsistent with an earlier FAO/WHO report (1997) which recognised the multifactorial cause of dental caries and suggested that programmes should focus on fluoridation and oral hygiene and not on sucrose intake alone. Conversely, the IOM (2002) was not able to determine, from the available evidence, an intake of sugars at which increased risk of dental caries could occur. Similarly, EFSA (2010) were not able to set an upper limit for intake of added sugars to reduce risk of dental caries. The US Dietary Guidelines (USDA/HHS, 2005) suggest that frequency and duration of exposure of all fermentable carbohydrates should be reduced and oral hygiene practices optimised. Similarly, EFSA (2010) state that frequent consumption of sugar-containing foods 4 can increase risk of dental caries, particularly when oral hygiene and fluoride prophylaxis are insufficient.

Fluoride

The use of fluoride toothpaste has proved to be the most successful approach to the prevention of dental caries. Fluoridation of water supplies is also beneficial but appears to be less effective than regular use of fluoride toothpaste. A review of the evidence for the effectiveness of dental health education was prepared for the UK DoH (Kay and Locker, 1996) and reported persuasive evidence supporting education regarding fluoride use, whereas dietary approaches did not appear to be worthwhile. The introduction of fluoride toothpaste has been remarkably successful in reducing caries prevalence among children and adults (Cottrell, 2011).

Statement

Frequent consumption of fermentable carbohydrates, including sucrose, has a role in the aetiology of dental caries. However, this role is substantially reduced when oral hygiene with use of fluoride toothpaste is adequate. Efforts to prevent dental caries should focus on achieving adequate oral hygiene practices with fluoride toothpaste as this has proven to provide a much greater reduction in caries experience than dietary modification. Dietary advice for the reduction of dental caries risk should focus on limiting the frequency of exposure to all fermentable carbohydrates.

References


STORY OF SWEETS

1. Chum Chum

Ingredients
1. Milk 2 liter
2. Sugar 1 cup
3. White flour 2 to 3 tbsp
4. White vinegar ½ cup
5. Kewra essence few drops
6. Baking powder 1 tsp
7. Almond pistachio ½ cup
8. Cooking Directions
10. When milk starts to boil, flame off the stove and put vinegar so milk curdles.
11. Now bind it in cloth and take out all the water.
12. Now put baking powder and white flour in it and mix it with the help of hand.
13. Now make balls from this batter.
14. Take a pan and put water sugar and kewra essence and cook it to make thick syrup.
15. Then put balls in it and cook on low flame.
16. When starts to float dish it out with syrup and garnish it with almond pistachio.

2. Blondies

Ingredients
1/2 cup of butter, melted
1 cup of tightly packed dark brown sugar
1 egg, lightly beaten
1 teaspoon of vanilla
1/2 teaspoon baking powder
1/8 teaspoon of baking soda
Pinch of salt
1 cup of all-purpose flour
1/3 cup of butterscotch chips (chopped walnuts and chocolate chips are equally tasty)

METHOD
1. Preheat the oven to 350°F. Lightly butter and flour an 8X8 pan. Whisk together the melted butter and sugar in a bowl.
2. Add the egg and vanilla extract and whisk.
3. Add the flour, baking soda, baking powder, and salt, mix it all together. Add the butterscotch chips or other mix-ins.
4. Pour into the pan and spread evenly. Bake for 20-25 minutes or until a toothpick comes out clean. Allow to cool. Cut into squares and serve.
5. Yield: Makes 9 blondies.
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