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ENERGY, ENVIRONMENT & EFFICIENCY MEASURES OF BAGASSE FIRED BOILERS, EFFECTIVE IMPLEMENTATIONS AT FARAN SUGAR MILLS

By
Mohammad Sarfaraz Khan
Faran Sugar Mills Limited, Hayderabad, Sindh

INTRODUCTION

Faran Sugar Mills commissioned during 1983 with two bagasse-fired boilers (FCB design) having initial evaporation capacity of 34 TPH at 24Kg/cm², 3300 °C working parameters. Initially both boilers supplied with economizers as sole heat recovery equipment without air-heater and ash collecting arrangement. Later on, in order to meets the enhanced crushing capacity, induction of other boilers as 50 TPH (Yoshimine) and Takuma 80 TPH has been added in the battery towards the end of 2006.

In order to attain rated generation and efficiency, a road map was planned in 2009 to implement phase-wise efforts to enhance capacity within the existing design setup. Certain modifications/implementations were therefore carried out in the areas as follows, Modification in boiler # 1 (FCB design undertaken).

Reasons for Modifying

Boiler is of FCB origin and has operated since 1983 for about 26 years. With passage of time, its capacity and efficiency was reduced considerably. Certain parts like economizer needed to be replaced due to its under rated out put. As a result the temperature of out going gases was increased in stack between 300 – 310 °C.

Operational inconsistencies

Operating the boiler was a difficult exercise, because of heap firing of bagasse in the furnace instead of suspended combustion of the same. Furnace backing was also a problem for boiler and was a safety hazard for the operators on site.

Achievements during season 2009

i. Boiler thermal efficiency was increased by 9% from 73% to 82 %. Temperature of out going Gases was controlled between (183 - 220 °C) as against stack temperature of 300-310 °C

ii. Overall efficiency has been increased by 11 % that is equal to 4T/Hr extra steam generation at no cost other.
than the design i.e. from 34 to 38 Tons/hr

iii. Operational difficulties have been overcome to certain extent. Boiler is operating smoothly, no backing and heap firing observed. Quality of flame is very good. Temperature is around 750 – 800 °C.

iv. Dust collector is working excellently thereby proving the apex capacity of the installed equipment; one of the significant aspects observed was the quantity of ash carried over to stack is almost negligible which ultimately is eco-friendly.

v. Inspite of 208 KW excess power consumption, we have attained an extra 4 TPH steam at no cost. Bagasse consumption has also reduced due to increase in thermal efficiency.

**Modifications Carried Out during 2nd phase (Off – season 2010)**

Targeted Figures for Economizers

![Diagram showing temperature levels between different components such as Gas, Water, and Air with corresponding temperatures ranging from 98 °C to 170-190 °C.]

**Figures of Entire Economizers during season 2009 – 10**

**CHARACTERISTIC OF INSTALLED ECONOMIZER AT FARAN SUGAR MILL BOILERS**

<table>
<thead>
<tr>
<th>DESIGN DATA</th>
<th>BOILER NO.1 (FCB)</th>
<th>BOILER NO.2 (FCB)</th>
<th>BOILER NO.3 (Yoshimine)</th>
<th>BOILER NO.4 (Takuma)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of application</td>
<td>Vertical</td>
<td>Horizontal</td>
<td>Vertical</td>
<td>Vertical</td>
</tr>
<tr>
<td>Operating pressure</td>
<td>40 Bar</td>
<td>40 Bar</td>
<td>40 Bar</td>
<td>40 Bar</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>&lt; 200 °C</td>
<td>&lt; 200 °C</td>
<td>&lt; 200 °C</td>
<td>&lt; 200 °C</td>
</tr>
<tr>
<td>Tube specification</td>
<td>50.8 Ø x 3.2</td>
<td>50.8 Ø x 3.2</td>
<td>50.8 Ø x 3.5</td>
<td>50.8 Ø x 3.5</td>
</tr>
<tr>
<td>Header Size Ø</td>
<td>220 x 7.11 x 6000</td>
<td>220 x 8.2 x 2000</td>
<td>220 x 7.2 x 7358</td>
<td>220 x 7.2 x 7358</td>
</tr>
<tr>
<td>Heating Surface (M²)</td>
<td>127</td>
<td>145</td>
<td>142</td>
<td>290</td>
</tr>
<tr>
<td>Cost of economizer @ Rs.6000/ H.S (M²)</td>
<td><strong>0.762 Million</strong></td>
<td><strong>0.876 Million</strong></td>
<td><strong>0.852 Million</strong></td>
<td><strong>1.74 Million</strong></td>
</tr>
<tr>
<td>Feed water inlet temperature (°C)</td>
<td>98</td>
<td>98</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Feed water outlet temperature (°C)</td>
<td>120 / 120</td>
<td>135 / 120</td>
<td>117 / 120</td>
<td>120 / 120</td>
</tr>
<tr>
<td>Rise in temperature (°C)</td>
<td>22</td>
<td>35</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Stack temperature before modification (°C)</td>
<td>310</td>
<td>500</td>
<td>210</td>
<td>220</td>
</tr>
<tr>
<td>Stack temperature after modification (°C)</td>
<td>206</td>
<td>*273</td>
<td>160</td>
<td>179</td>
</tr>
<tr>
<td>Efficiency increased %</td>
<td>2.2</td>
<td>3.5</td>
<td>1.9</td>
<td>2.5</td>
</tr>
<tr>
<td>Bagasse saved / season (M. Tons)</td>
<td>816</td>
<td>1295</td>
<td>1036</td>
<td>2161</td>
</tr>
<tr>
<td>Cost of bagasse that saved @ Rs. 1900 /Ton</td>
<td><strong>1.22 Million</strong></td>
<td><strong>1.94 Million</strong></td>
<td><strong>1.59 Million</strong></td>
<td><strong>3.27 Million</strong></td>
</tr>
<tr>
<td>Pay back</td>
<td>One Season</td>
<td>One Season</td>
<td>One Season</td>
<td>One Season</td>
</tr>
</tbody>
</table>
Cost of economizer Rs.6,000 / M² Heating Surface (Material Plus Labour)

* Boiler No.2 is still on original design i.e. without air heater & ash collector. However, we’ve enhanced the heating surface of existing economizer during season 2010-11. Additionally, primary air heated up to 110 °C against ambient to the original design to attain efficiency.

Pay back with in season (Achieved)

(Economizer Cost Vs Payback Graphical presentation)

REPLACEMENT OF ID FANS

CHARACTERISTICS OF ID FANS

STEAM PRODUCTION

ENHANCEMENT AFTER MODIFICATION

CHARACTERISTICS OF CAPACITY

PROVISION OF HOT AIR DUCT FROM FCB BOILER # 1 TO FCB BOILER # 2

Boiler # 2 (FCB) was designed to provide ambient air to furnace with secondary ducting too. This contributed poor thermal efficiency to the combustion. In order to attain better efficiency, a duct was introduced from Boiler # 1 FCB air heater out let to utilise excess fan capacity. This activity enhances primary air temperature up to 110 °C from ambient temperature. Due to improvement in combustion thermal efficiency enhanced up to 4%.

1780 M. tons bagasse saved Payback within season 2.67 million @ Rs.1500/ton bagasse

An investment Vs pay back graph is as under for productivity assessment

HOT AIR DUCT FROM FCB BOILER # 1 TO FCB BOILER # 2

Steam Purification and quality

Generally, in our systems, the steam produced is supplied directly from boiler to the distribution header without any further dryness. This happens with Takuma, Yoshimine and Backau – Wolf boilers.

As observed on most of the plants, steam quality is not ensured due to boilers of different operating parameters (variation in Pressure & Temperature). The quality of steam remains available with average enthalpy contents that are contributing in reduction in efficiency.

We have experienced frequency of carry over in the past especially from HMC design (Takuma) boiler of 80 TPH capacity. After assessment it has been observed that drum internal integrals becomes inefficient and steam generated directly moves to steam distribution header as per their design. The quality of steam suffers when boiler load reaches to the rated capacity.

MESH DEMISTER PAD

In order to explore solution due to capacity enhancement, Mesh demister was imported from abroad for steam drums internals to trap the suspended liquid particles up to 3 – 5 μm. Additionally a steam separator of FCB design was introduced in the steam distribution system to ensure steam quality before going to the steam turbines.

(Cost of Mesh Demister pad Rs.70, 000=)

Temperature reduction

Shown in figure below, is a typical FCB design steam separator which has capacity to produce quality steam. Due to its typical internal arrangement, the pressure drop is negligible and dryness ensured. Subsequently, the prime movers efficiency is improved and consumption considerably reduced due to improved stable enthalpy contents.

After induction of the said arrangement temperature rose up to 7 – 10 °C resulting in improved in enthalpy contents which in turns improved turbine efficiency with added steam quality. Combination of entire arrangement from drum to steam separator prior to steam distributing header is as follows:-
ACKNOWLEDGEMENT

I am thankful to the management of Faran Sugar Mills to provide me with an opportunity to present this Technical Paper here at PSST annual convention 2011.

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Steam Purification system
FCB Manual for bagasse fired boilers (34 – 45 TPH Boilers)
Design documents for up grading from 34 to 38 TPH FCB boilers
EXPLORING RATOO POTENTIAL OF VARIOUS SUGARCANE VARIETIES UNDER SOUTHERN PUNJAB CONDITIONS
By
Muhammad Aslam* Naeem Ahmad* Muhammad Naseem** Abdul Rashid Zahid***
* Sugarcane Research Station, Khanpur ** Agronomic Research Station, Farooqabad
*** Sugarcane Research Sub Station, Bahawalpur

ABSTRACT

Seven new promising sugarcane varieties viz., S2002US.312, S2002US.447, S2002US.628, S2003US.114, S2003US.123, S2003US.809 and S2003US.824 were evaluated for their ratoon yield and quality against a commercial cultivar HSF.240 under Southern Punjab conditions during 2011 at Sugarcane Research Station, Khanpur. The variety S2003US.114 on account of good sprouting per plant (2.84), higher 100-cane weight (97.33 kg), reasonably good millable cane count (111.30 thousand ha⁻¹), significantly maximum cane yield of (108.05 t/ha) and comparable CCS% (12.41) against check HSF-240, produced the highest sugar yield of 13.41 t/ha. It was followed by S2003US.824. The promising variety S2003US.114 on the basis of 15.65 and 15.21% more ratoon cane and sugar yield, respectively over control is capable of replacing the check variety and can make gigantic strides in sugarcane production for sweet revolution. A wide scale testing in various agro-ecological zones is, however, invited for regional adaptability.

Keywords: Varieties, Ratoon Potential, commercial cane sugar, millable cane, sugarcane.

INTRODUCTION

Ratooning potential of a sugarcane variety is one of the most desirable cane genotypic characters from farmer's point of view. Only a good ratooner sugarcane variety gains popularity among the farming community. Ratoons are cheaper to grow by about 30-40% due to saving in soaking irrigation, land preparation, cost of seed and sowing operations (Akhtar et al, 2003). Ratoon crop occupies 35 to 50 % of the total cane area in Pakistan (Malik and Guman, 2005). Afzal et al, 1990 studied the ratoon performance of six sugarcane varieties and reported maximum average cane yield of 75.55 t/ha for CP-43-33. The same variety surpassed in sugar yield. El-Geddawy et al, 2002 elucidated that sugarcane variety GIT.54-9 significantly surpassed the other varieties in respect of stalk height, stalk diameter and stalk weight in both ratoon crops. Rafique et al, 2005 carried out two years field experiment to investigate ratooning potential of ten sugarcane varieties and concluded that CPF-243 and HSF-240 gave significantly more ratoon yield during both years of study. Bashir et al, 2007 undertake a field study on ratooning ability of spring planted sugarcane varieties and observed that maximum cane yield was produced by CPF-237 and HSF-242 of ratoon crop. Jamil et al, 2007 evaluated the ratooning behavior of 22 candidate sugarcane varieties under NUYT programme. Findings of the study revealed that promising sugarcane varieties S95HS.185, S97US.183, S96SP.302, CPHS.35, NSG.311 and Malakand-16 were better ratooners. Khan et al, 2007 indicated that sugarcane variety S96SP.302 produced significantly maximum ratoon cane yield of 79.39 t/ha against the lowest cane yield of 41.94 t/ha recorded for NSG-311. The higher cane yield was mainly associated with higher number of millable canes, cane height, and cane girth. Therefore, a study was planned in this context to assess the comparative ratooning performance of candidate sugarcane varieties under Southern Punjab conditions. Aslam et al, 2011 studied the ratoon performance of thirteen sugarcane varieties and found that CPF.246 on account of high number of sprouting per plant (1.57), significantly higher 100-cane weight (95.67 kg), highest millable cane count (112.69 thousand ha⁻¹), maximum cane yield (107.90 t/ha) and comparable CCS% (12.74) against check SPF-234, produced the highest sugar yield of 13.74 t/ha.

MATERIALS AND METHODS

The field experiment was conducted under irrigated conditions during spring season to evaluate the ratoon potential of elite sugarcane varieties during 2011-2012 at Sugarcane Research Station, Khanpur. The experiment was started during 2011 when the spring planted crop was harvested in the first week of February and kept as ratoon. The verities included in the study were S2002US.312, S2002US.447, S2002US.628, S2003US.114, S2003US.123, S2003US.809, S2003US.824 and HSF.240. The experiment was laid out in Randomized Complete Block Design with three replications. The sugarcane genotypes were sown by dry method in 120cm apart trenches with a net plot of size 3.6 x 10 m using a seed rate of 75000 double budded sets per hectare. The ratoon crop was fertilized at the rate of 218-146-146 kg NPK per hectare, respectively. After harvesting the plant crop, uneven stubbles were cut manually with the help of hand chopper. Then interculture was given to control...
weeds, loosen the soil to help root development and thus facilitate sprouting. Afterwards, whole of P, K and 1/3 of N was applied to the crop followed by irrigation. The remaining 2/3 N was given in two equal splits, 1/3rd at completing sprouts (60 days after harvesting of plant crop) and 1/3rd during the second fortnight of May when crop was earthed up. Meanwhile data on number of sprouts per plant were recorded. The data on cane density, weight, yield and quality were recorded at the harvest during the last week of December, 2011. The data thus recorded were analyzed using Analysis of variance technique and least significance difference test was applied to compare the treatment means (Steel and Torrie, 1984).

RESULTS AND DISCUSSIONS

Number of sprouts per plant
The sprouting of underground buds plays a pivotal role in the establishment of an economical ratoon sugarcane crop. Climatic conditions, soil moisture and vigor of plant crop play a very important role in determining the sprouting of stubbles. It is evident from the data given in table-1 that there were significant differences in the number of sprouts per plant produced by different sugarcane varieties under study. Sugarcane genome S2003US.123 produced the highest number of sprouts per plant (2.93). It was, however, matchingly followed by S2003US.114, S2003US.824, HSF.240 and S2003US.809. These differences in the number of sprouts per plant may be attributed to the varied inherent ratooning potential of the varieties (Rafique et al. 2005).

Cane Weight
The individual cane weight is a very important yield contributing character which directly affects the final yield. The data presented in the table-1 show significant differences in the 100-cane weight given by different genomes. Promising sugarcane variety S2003US.824, produced the heaviest canes (99.00 kg per 100 canes). It was, however, matchingly followed by S2003US.114 and S2003US.123. The lowest 100-cane weight of 76.67 kg was recorded for S2002US.312 preceded by S2002US.447. These differences in the stalk weight may be attributed to the varied genetic potential of tested sugarcane clones. Aslam et al, 2011 have also recorded the varied cane weight for different sugarcane varieties.

Cane Density
Adequate number of potentially heavy millable canes ensures high yield. The establishment of millable canes is a direct reflection of stubble sprouts in ratoon crop of sugarcane if tiller mortality remains the same. The data compiled in table-1 depict that the standard variety HSF.240 produced more number of millable canes against all other varieties under investigation (115.09 thousand ha\(^{-1}\)). It was followed by S2003US.809 and S2003US.114 however the differences were non significant. The thinnest stand of 96.39 thousand cane stalks was recorded for S2002US.628 which was non-significantly preceded by S2003US.123. The differential behavior of sugarcane genotypes though non significant for the production of variable number of millable canes may be attributed to the varying inherent potential of different genetic make ups to exploit environmental resources.

Stripped Cane Yield
Economically high cane yield is the ultimate goal of every grower which is the function of the well coordinated inter-play of genetic constitution and the environment to which it is exposed. Different yield attributes like number of millable canes, cane height, cane girth and thus per cane weight have direct bearing in the final stripped cane yield per unit area. The data embodied in the table -1 indicated that the tested strains differed substantially in final cane yield. The promising sugarcane variety S2003US.114 gave significantly highest ratoon cane yield of 108.05 t/ha. It was matchingly followed by S2003US.824 with a final tonnage of 101.30 per hectare. Afzal et al.1990, EL-Geddaway et al. 2002, Rafique et al. 2005, Bashir et al., 2007, Jamil et al., 2007 and Aslam et al, 2011 have also reported the varied tonnage of ratoon stripped canes for different genotypes.

Sugar Yield
The underlined goal of all efforts made by a Breeder or an Agronomist is the attainment of higher tonnage of crystal sugar which is actually produced in the field and collected in the factory. It is evident from the data given in table-1 that all the varieties / promising clones under study behaved differently from one another for the production of sugar yield. The highest sugar yield of 13.41 t/ha was produced by the promising clone S2003US.114, closely followed by S2003US.824. The least amount of white sugar (9.71 t/ha) was recorded for S2002US.628. This differential behavior of sugarcane varieties / strains to produce sugar yield may be attributed to the variability in their genetic constitution to exploit environment. Rafique et al. 2005, Bashir et al., 2007 and Aslam et al, 2011 have also received varied sugar yield for different genotypes.
Table 1 Ratoon performance of sugarcane varieties under Southern Punjab conditions

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Variety</th>
<th>Sprouts 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>S2002US.312</td>
<td>1.46c</td>
<td>76.67b</td>
<td>105.46</td>
<td>79.44d</td>
<td>13.11</td>
<td>10.41</td>
</tr>
<tr>
<td>2</td>
<td>S2002US.447</td>
<td>1.72c</td>
<td>80.33b</td>
<td>101.11</td>
<td>81.20c</td>
<td>12.21</td>
<td>9.91</td>
</tr>
<tr>
<td>3</td>
<td>S2002US.628</td>
<td>2.16b</td>
<td>82.00b</td>
<td>96.39</td>
<td>78.52d</td>
<td>12.37</td>
<td>9.71</td>
</tr>
<tr>
<td>4</td>
<td>S2003US.114</td>
<td>2.84a</td>
<td>97.33a</td>
<td>111.30</td>
<td>108.05a</td>
<td>12.41</td>
<td>13.41</td>
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<td>5</td>
<td>S2003US.123</td>
<td>2.93a</td>
<td>89.67ab</td>
<td>99.91</td>
<td>89.26bc</td>
<td>12.65</td>
<td>11.29</td>
</tr>
<tr>
<td>6</td>
<td>S2003US.809</td>
<td>2.63a</td>
<td>81.33b</td>
<td>114.17</td>
<td>92.69b</td>
<td>12.44</td>
<td>11.53</td>
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<td>7</td>
<td>S2003US.824</td>
<td>2.79a</td>
<td>99.00a</td>
<td>108.43</td>
<td>101.30a</td>
<td>12.37</td>
<td>12.53</td>
</tr>
<tr>
<td>8</td>
<td>HSF.240</td>
<td>2.65a</td>
<td>81.67b</td>
<td>115.09</td>
<td>93.43b</td>
<td>12.46</td>
<td>11.64</td>
</tr>
<tr>
<td></td>
<td>LSD 0.05</td>
<td>0.35</td>
<td>14.98</td>
<td>N.S</td>
<td>8.48</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

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

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ABSTRACT

A field experiment was conducted at Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi-6620, Pabna, Bangladesh during 2009-2010 cropping season to evaluate some qualitative and quantitative characters of ten sugarcane genotypes under water-logging stress condition. The genotypes were I 124-00, I 112-01, I 7-03, I 78-03, I 111-03, I 137-03, I 231-03, and water-logging commercial varieties Isd 39 (Standard) and Isd 40 (Standard). Significantly highest number of tillers was recorded in genotype I 231-03 (137.73 × 10³ ha⁻¹) and highest number of millable cane was recorded in variety Isd 39 (99.76 × 10³ ha⁻¹). The significantly highest cane yield was obtained in variety Isd 39 (98.04 t ha⁻¹), and the lowest cane yield was obtained in genotype I 111-03 (51.83 t ha⁻¹). Significantly highest Brix per cent, highest pol per cent juice, highest pol per cent cane, highest purity per cent, highest recoverable sucrose per cent were found in genotype I 124-00 under water-logging stress condition, respectively. The highest sugar yields was obtained in variety Isd 39 (10.88 t ha⁻¹) followed by variety Isd 40 (10.49 t ha⁻¹), genotype I 231-03 (10.22 t ha⁻¹) and the lowest was genotype I 139-03 (5.47 t ha⁻¹). Genotype I 231-03, Isd 39 and Isd 40 are highly tolerant having tolerance rating scale 1 against induced water-logging stress condition. Thus, the genotype I 231-03 proved highly potential tolerant in respect of cane yield, sugar yield, juice quality and utilization of potentiality breeding as parents to evolve varieties resistant to water-logging.

Keyword: Sugarcane, yield, pol % cane and water-logging.

INTRODUCTION

Water-logging is associated with monsoon rainfall, river floods, in adequate and improper drainage facilities due to unplanned road development in Bangladesh. Cane yield and juice quality loss due to water-logging depends upon genotype, environmental conditions, stage of development and duration of inundation (Orchard and Jessop, 1984). In sugarcane cultivation, water-logging is an acute problem particularly where surface drainage facilities are inadequate. Due to growing demand of cereal and vegetables crops one-third areas of land where sugarcane is grown are relatively low lying where water remains stagnant for longer period resulting poor growth and yield. Higher water table during active growth phase adversely affects stalk weight and plant population resulting yield loss at the rate of about one ton per acre for one inch increase in excess water (Carter and Floyed 1974 and Carter 1976), although sugarcane is a relatively tolerant to high water tables and flooding (Roach and Mullins, 1985; Kang et al. 1986; Deren et al. 1991a, Deren et al. 1991b and Deren et al. 1993). Well-established cane survives few months in to flood, while less established cane appears to be much more vulnerable to flooding (Deren and Raid, 1997). The cause of low yield, attributed to low moisture and nitrogen in the tissue at grand growth phase. Increase in number of internodes, profuse tillering and increase in % P in plant but decrease in nitrogen content are the characteristics tolerance to flood condition (Pandey, 1964). Some physiological effects of cane are found due to water-logging are (i) transpiration rates are reduced due to stomata closure, (ii) rate of photosynthesis is considerably reduced presumably that causes the reduction of effective leaf areas, (iii) growth rates are drastically reduced during water-logging (iv) higher respiration rate of submerged organs compared to leaves. A shift in respiratory metabolism from aerobic to anaerobic pathways is one of the main effects of oxygen deficiency causing from water-logging. This result is accumulation of various end products of an aerobic respiration and rapid depletion of organic compounds. The effects of water-logging on respiration rate depend on the varieties, and on its physiological age. Nutrient uptake is badly affected under water-logging where aerobic respiration by sugarcane root system is poor (Singh, 1990). It is also reported that under water-logging condition, some morphological, anatomical, physiological and biochemical changes take place in plant for the sack of adaptation/survival (Barelay and Crawford, 1982). In general, water-logging induces anaerobic condition in soil. It also leads to a real rooting resulting rapid moisture loss, increase fiber per cent and non-sugars and yellowing of leaves in anaerobic state during water-logging condition (Malik and Tomer, 2003). Therefore, the present study was undertaken with the objectives to investigate the some qualitative and quantitative characters of ten sugarcane genotypes under water-logging stress condition.
MATERIALS AND METHODS

The trial was conducted at the experimental farm and laboratory of the Physiology and Sugar Chemistry Division in Bangladesh Sugarcane Research Institute (BSRI), Ishurdi-6620, Pabna, Bangladesh during November 14, 2009 to December 25, 2010. The site is located at 24°8' North latitude and 89°04' East longitude and situated about 15.5 m above the mean sea level. The experimental site represents the High Ganges River Flood Plain soils under the AEZ 11. Eight genotypes viz. I 124-00, I 112-01, I 7-03, I 78-03, I 111-03, I 137-03, I 231-03 and two water-logging tolerant slandered variety Isd 39, Isd 40 were tested. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Two budded sets were planted at furrow following end to end method of planting in the month of November, 2009. Row to row distance was maintained 100 cm. The fertilizers were applied @ 325 kg urea, 250 kg TSP, 190 kg MP, 180 kg Gypsum and 9 kg ZnSO₄ per hectare. Urea was applied in 3 splits and MP was applied in two splits. Total TSP, ZnSO₄, half of MP, one third urea were applied at planting. Rest of urea and MP were applied as top dressing. For controlling insect pests, chlorpyrifos (trade name: regent 3 GR) was applied @ 33 kg ha⁻¹ during planting and carbofuran (trade name: furadan 5G) was applied @ 40 kg ha⁻¹ in two splits between March to May, 2010. All cultural practices were done as and when required. Water-logging treatment was imposed by deep tube well water. The experimental field was inundated and maintained at least 90 cm deep water for 120 days (15 June to 15 October). Tillering was recorded at an interval of 30 days starting from March until August. Millable cane and cane yield were recorded at harvest in the month of December 25, 2010.

Stalk height at harvest
At harvest 20 cane stalks were selected randomly and the length of individual cane stalk was measured from the bottom to the top using a meter tape. The stalk height of cane was expressed in m.

Cane diameter
Slide calipers from 20 randomly selected stalks measured the stalks diameter. Average of bottom, middle and top diameter was considered as the actual diameter of the cane stalks. The cane diameter was expressed in cm.

Chemical analysis of sugarcane juice
Chemical analyses of sugarcane juice for Brix (%), pol (%), purity (%) and reducing sugar (%) were done at harvest of sugarcane. Randomly selected 15 sample cane stalks were crushed with a mini power crusher to get juice for analysis. Brix was determined by Brix hydrometer standardized at 20°C and sucrose determination was done using automatic Polarimeter (AP-300), ATAGO® Company limited, Made in Japan, by Horne’s dry lead method. Pol% cane per cent was calculated by the method prescribed in Queensland Laboratory Manual (Anon, 1970).

Brix (%)
Percentage of total soluble solids present in solution (juice)

Purity (%)
Percentage of pure sucrose in dry matter = \( \frac{Pol}{Brix} \times 100 \)

Pol % Cane
Percentage of sucrose content in whole cane.

Recoverable sucrose
The recoverable sucrose (%) was calculated by using the following formula:

\[ \text{Recoverable sucrose} = \left( \frac{\text{Pol} - \text{Brix}}{2} \right) \times \text{Juice factor} \]

Where, juice factor was 0.65 (extraction percentage)

Sugar yield
Sugar yield was calculated using the following formula:

\[ \frac{\text{Sugar yield (t ha}^{-1}) \times \text{Cane yield (t ha}^{-1})}{\text{Recoverable sucrose}} \times 100 \]

RESULTS AND DISCUSSION

Tiller production
Water-logging stress condition as affected significantly in tiller production of sugarcane. The results on tiller have been presented in Table 1. The highest number of tillers was recorded in genotype I 231-03 (137.73 × 10³ ha⁻¹) and the lowest tiller production was observed in genotype I 137-03 (115.35 × 10³ ha⁻¹) under water-logging stress condition.

MILLABLE CANE PRODUCTION
The results on millable cane have been presented in Table 1. Significantly highest number of millable cane was recorded in variety Isd 39 (99.76 × 10³ ha⁻¹) followed by variety Isd 40 (97.41 × 10³ ha⁻¹) while the lowest millable cane production was observed in genotype I 111-03 (72.83 × 10³ ha⁻¹). Similar results were also reported by Islam et al. (2011b), Islam et al. (2009a) and Hasan et al. (2003) under water-logging stress condition.

Stalk height
Significantly highest stalk height was recorded in varieties Isd 39 (2.81m) and while the lowest stalk height was obtained in genotype I 111-03 (2.24m) (Table 1). These
results are in agreement with findings of Alam et al. 2010, Rahman et al. 2010 and Islam et al. 2009c.

Stalk diameter
It was also seen from the Table 1 that the highest stalk diameter was obtained in variety Isd 39 (2.72 cm) and the lowest stalk diameter was obtained in genotype I 111-03 (2.06 cm). The findings of the present experiment are in agreement with Alam et al. 2010 and Kabiraj et al. 2007.

Cane yield
Cane yield have been shown in the Table 1. It was seen that the significantly highest cane yield were obtained in variety Isd 39 (98.04 t ha⁻¹) and the lowest cane yield was obtained in genotype I 111-03 (51.83 t ha⁻¹). The results were in agreement with Islam et al. (2011a), Rahman et al. (2010), Islam et al. (2009a) Islam et al. (2009b), Islam et al. (2007), Kabiraj et al. (2007), Paul et al. (1994) and Miah et al. (1994) described different sugarcane varieties/promising genotypes and revealed different trend for cane yield per unit area.

Brix (%)
Table 2 shows that the highest Brix per cent were found under water-logging stress condition in genotype I 124-00 (20.8%), followed by genotype I 7-03 (20.2%), genotype I 111-03 (20.2%), variety Isd 40 (20.2%), genotype I 231-03 (20.0%), genotype I 112-01 (19.9%), variety Isd 39 (19.8%) while the lowest Brix per cent obtained in genotype I 78-03 (17.8%). These results were in agreement with findings of Islam et al. (2011a), Islam et al. (2011b), Rahman et al. (2010), Islam et al. (2009a), Islam et al. (2007) and Kabiraj et al. (2007) who studied Brix per cent of sugarcane varieties/clones and found different levels of Brix per cent.

Pol % juice
Pol % juice has been presented in the Table 2 and found that the highest pol % juice were obtained in variety I 124-00 (18.96%) and the lowest was I 78-03 (15.48%).

Pol % cane
Table 2 shows that the significantly highest pol per cent cane was found under water-logging stress condition in genotype I 124-00 (14.79%) and the lowest pol percent cane in genotype I 78-03 (12.07%). The results were in well agreement with the findings of Islam et al. (2011a) and Islam et al. (2011b).

Purity (%)
Purity per cent has been shown in Table 2. It was seen that the significantly highest purity per cent were obtained in genotype I 124-00 (91.17%) and the lowest purity per cent was obtained in genotype I 139-03 (86.17%). Present findings agree with the findings of Islam et al. (2011a) who carried out studies on purity per cent in one commercial variety/five clones and found different results for purity per cent under water-logging stress condition.

Recoverable sucrose (%)
Recoverable sucrose per cent has been shown in Table 2. It was seen that the highest recoverable sucrose per cent was obtained in genotype I 124-00 (11.73%) followed by variety Isd 39 (11.10%) and variety Isd 40 (11.02%). The lowest recoverable sucrose per cent was obtained in genotype I 78-03 (9.31%). Similar results were also reported by Islam et al. (2011a) Islam et al. (2011b) and Islam et al. (2007).

Sugar yield
Sugar yield has been presented in the Figure 1 and found that the highest sugar yield were obtained in variety Isd 39 (10.88 t ha⁻¹) followed by variety Isd 40 (10.49 t ha⁻¹), genotypes I 231-03 (10.22 t ha⁻¹) and the lowest was I 139-03 (5.47 t ha⁻¹). The results were in agreement with the finding of Islam et al. (2011a), Islam et al. (2011b) and Islam et al. (2007).

Tolerance rating scale
Tolerance rating scale was measured on the basis of tiller number, millable cane number, cane yield, sugar yield, Brix per cent, purity per cent, pol per cent cane, and recoverable sucrose percent. Results of tolerance rating scale have been presented in Figure 1. It revealed that genotype I 231-03, variety Isd 39, variety Isd 40 were highly tolerant having tolerance rating scale 1 and genotypes I 124-00 was found to be tolerant to water-logging stress having tolerance rating 2. Genotypes I 112-01 and I 7-03, I 78-03 were found to be moderately tolerant to water-logging stress having tolerance rating scale 3 and genotypes I 111-03, I 137-03 and I 139-03 were found to be intolerant to water-logging stress having tolerance rating scale 4 against induced water-logging stress condition. These findings were in well agreement with the findings of Islam et al. (2011a), Islam et al. (2011b), Islam et al. (2009a) and Islam et al. (2009b).

CONCLUSION
It may be concluded that genotype I 231-03 may be considered as highly tolerant on the basis of cane yield, sugar yield and juice quality under induced water-logging stress condition.
Table-1  Yield and yield attributing parameters of ten sugarcane genotypes under water-logging stress condition

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>No. of tiller (10³ ha⁻¹)</th>
<th>No. of millable cane (10³ ha⁻¹)</th>
<th>Stalk height (m)</th>
<th>Stalk diameter (cm)</th>
<th>Cane yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 124-00</td>
<td>121.28b</td>
<td>91.23abc</td>
<td>2.74ab</td>
<td>2.62ab</td>
<td>76.54b</td>
</tr>
<tr>
<td>I 112-01</td>
<td>119.63b</td>
<td>83.51cd</td>
<td>2.63abc</td>
<td>2.57ab</td>
<td>65.62c</td>
</tr>
<tr>
<td>I 7-03</td>
<td>121.65b</td>
<td>80.09de</td>
<td>2.51cd</td>
<td>2.48b</td>
<td>61.85c</td>
</tr>
<tr>
<td>I 78-03</td>
<td>120.92b</td>
<td>86.25bcd</td>
<td>2.57bc</td>
<td>2.54ab</td>
<td>63.57c</td>
</tr>
<tr>
<td>I 111-03</td>
<td>125.37b</td>
<td>72.83e</td>
<td>2.24e</td>
<td>2.06c</td>
<td>51.83d</td>
</tr>
<tr>
<td>I 137-03</td>
<td>115.35b</td>
<td>76.87de</td>
<td>2.27e</td>
<td>2.15c</td>
<td>53.05d</td>
</tr>
<tr>
<td>I 139-03</td>
<td>118.26b</td>
<td>78.53de</td>
<td>2.31de</td>
<td>2.18c</td>
<td>54.51d</td>
</tr>
<tr>
<td>I 231-03</td>
<td>137.73a</td>
<td>95.91ab</td>
<td>2.78ab</td>
<td>2.65ab</td>
<td>94.54a</td>
</tr>
<tr>
<td>Isd 39 (Standard)</td>
<td>124.47b</td>
<td>99.76a</td>
<td>2.81a</td>
<td>2.72a</td>
<td>98.04a</td>
</tr>
<tr>
<td>Isd 40 (Standard)</td>
<td>122.68b</td>
<td>97.41a</td>
<td>2.79ab</td>
<td>2.69a</td>
<td>95.25a</td>
</tr>
<tr>
<td>Level of significant</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>CV (%)</td>
<td>5.11</td>
<td>6.25</td>
<td>4.81</td>
<td>3.99</td>
<td>5.15</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>10.77</td>
<td>9.24</td>
<td>0.21</td>
<td>0.17</td>
<td>6.31</td>
</tr>
</tbody>
</table>

** Significant at 1% level of probability, * Significant at 5% level of probability, NS = Not significant

Table-2  Juice quality and sugar yield of ten sugarcane genotypes under water-logging stress condition

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Brix (%)</th>
<th>Pol % juice</th>
<th>Pol % cane</th>
<th>Purity (%)</th>
<th>Recoverable sucrose (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 124-00</td>
<td>20.8a</td>
<td>18.96a</td>
<td>14.79a</td>
<td>91.17a</td>
<td>11.73a</td>
</tr>
<tr>
<td>I 112-01</td>
<td>19.9a</td>
<td>17.76a</td>
<td>13.86a</td>
<td>89.26abc</td>
<td>10.84b</td>
</tr>
<tr>
<td>I 7-03</td>
<td>20.2a</td>
<td>17.87a</td>
<td>13.94a</td>
<td>88.48bcd</td>
<td>10.85b</td>
</tr>
<tr>
<td>I 78-03</td>
<td>17.8c</td>
<td>15.48b</td>
<td>12.07b</td>
<td>86.97cd</td>
<td>9.31d</td>
</tr>
<tr>
<td>I 111-03</td>
<td>20.2a</td>
<td>17.80a</td>
<td>13.88a</td>
<td>88.10cd</td>
<td>10.79b</td>
</tr>
<tr>
<td>I 137-03</td>
<td>19.7ab</td>
<td>17.59a</td>
<td>13.72a</td>
<td>89.29abc</td>
<td>10.74bc</td>
</tr>
<tr>
<td>I 139-03</td>
<td>18.7bc</td>
<td>16.11b</td>
<td>12.57b</td>
<td>86.17d</td>
<td>10.05c</td>
</tr>
<tr>
<td>I 231-03</td>
<td>20.0a</td>
<td>17.76a</td>
<td>13.86a</td>
<td>88.82abc</td>
<td>10.81b</td>
</tr>
<tr>
<td>Isd 39 (Standard)</td>
<td>19.8a</td>
<td>17.99a</td>
<td>14.03a</td>
<td>90.85ab</td>
<td>11.10ab</td>
</tr>
<tr>
<td>Isd 40 (Standard)</td>
<td>20.2a</td>
<td>18.04a</td>
<td>14.07a</td>
<td>89.33abc</td>
<td>11.02ab</td>
</tr>
<tr>
<td>Level of significant</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.07</td>
<td>4.89</td>
<td>4.64</td>
<td>1.49</td>
<td>3.81</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>1.04</td>
<td>1.47</td>
<td>1.09</td>
<td>2.28</td>
<td>0.70</td>
</tr>
</tbody>
</table>

** Significant at 1% level of probability, * Significant at 5% level of probability, NS = Not significant
Figure-1  Sugar yield (t ha⁻¹) and tolerance rating scale of ten sugarcane genotypes under water-logging stress condition. ***Tolerance rating scale (1-5), where, 1 = Highly tolerant, 2 = Tolerant, 3 = Moderately tolerant, 4 = Intolerant and 5 = Highly intolerant.

REFERENCES


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EFFECT OF TRASH MULCH AND N LEVELS ON CANE YIELD AND RECOVERY OF SUGARCANE VARIETY THATTA-10

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ABSTRACT

A field trial was conducted during the year 2009-10 to investigate the effect of trash mulch and various N levels on the cane yield and recovery of sugarcane variety Thatta-10. The treatments included: Control (No mulch, 225 kg N ha⁻¹), trash mulch + 225 kg N ha⁻¹, trash mulch + 250 kg N ha⁻¹, trash mulch + 275 kg N ha⁻¹ and trash mulch + 300 kg N ha⁻¹. The experiment was laid out in a three replicated randomized complete block design in a plot size of 14 m x 3 m (42 m²). The results revealed that regardless the N levels, the mulching showed positive and significant impact on cane yield and recovery of sugarcane variety Thatta-10. However, trash mulch + 250 kg N ha⁻¹ treatment resulted economically superior performance over rest of the treatments with 64 percent germination, 246 cm cane length, 2.67 cm cane girth, 22.2 internodes cane⁻¹, 117.67 tons ha⁻¹ cane yield and 10.90 percent sugar recovery. It was concluded that systematically applied trash mulch showed positive impact on all the studied traits of sugarcane variety Thatta-10 including cane yield and recovery. Moreover, higher N levels of 300 and 275 kg ha⁻¹ slightly increases cane length, but cane girth, internodes, cane yield and recovery decreased over 250 kg ha⁻¹ N level. This indicates that for obtaining economically maximum crop performance for sugarcane variety Thatta-10, the sugarcane may be trash-mulched and N may be applied at the rate of 250 kg ha⁻¹.

Keywords: Sugarcane, trash mulch, Nitrogen, cane length, cane girth, cane yield, recovery

INTRODUCTION

Sugarcane is a major cash crop of Pakistan and source of livelihood for hundreds of thousands people in Pakistan (Afgan et al. 2010). It belongs to the family Gramineae (Miller and Gilbert, 2010); and it contributes 3.6 percent in value added to agriculture and 0.8 percent to GDP. The sugarcane was cultivated on an area of 1046 thousand hectares in Pakistan (2011-2012) with a total cane production of 58.038 million tons (GoP, 2012). Out of total seventy eight sugar mills in Pakistan, only in Sindh province has 31 sugar mills and the province is considered as second highest contributor to total sugarcane production in Pakistan after Punjab. The sugarcane in Sindh province of Pakistan was cultivated on an area of 280 thousand hectares with a production of 15350 thousand tons (Carroll and Rehman, 2010) during 2009-2010; and actual area under sugarcane cultivation during 2010-2011 was 292.5 thousand hectares against the targeted area of 270 thousand hectares (GoS, 2011). Mulch is a protective cover placed over the soil to retain moisture, reduce erosion, provide nutrients, and suppress weed growth and seed germination. Organic mulching has importance by environmental concerns. Increasing cost of herbicides/ weedicides on one hand and their undesirable impacts on the soil health on the other hand call for immediate inclusive of organic mulch materials. Due to wider use of short statured high yielding varieties and hybrids in different crops, the availability of crop residue as a source of organic matter for soil is very much limited. Farmyard manure and green manure are used only on limited scale as organic sources since most of the plant residues are consumed as fuel (Yadahalli, 2008).

Soil organic matter is an important feature of soil fertility. Ways of increasing soil organic matter are by growing a cover crop (green manure) or by mulching with compost or crop residues. These practices also help to control weed growth. Mulching has been shown increased crop yields (Kaniszewski, 1994). Mulching by crop residues was superior to polyethylene sheets (used to control weeds) in terms of incremental cost-benefit ratios (Khalak and Kumaraswamy, 1993). There are several reports of improvement of soil fertility as a result of mulching with crop residues (Kitou and Yoshida 1994).

Mulching reduces the deterioration of soil by way of preventing the runoff and soil loss, minimizes the weed infestation and checks the water evaporation. Thus, it facilitates for more retention of soil moisture and helps in control of temperature fluctuations, improves physical, chemical and biological properties of soil, as it adds nutrients to the soil and ultimately enhances the growth and yield of crops (Dilipkumar et al. 1990). Crop residues are
tremendous natural resource for recycling. Crop residues of common cultivated crops are important resources not only as a source of significant quantity of nutrients but also affecting soil physical, chemical and biological functions and properties, water and soil quality (Gaur et al. 1995). The soil is living only when it will have a microbial population of 108 per cubic centimeter of soil. These microbial populations need adequate quantity of organic manures as feed for their survival and multiplication (Babalad, 2008).

Nutrient requirement of sugarcane can be determined on the basis of respective nutrient in selected index tissues at specific crop stages. Higher growth rate of sugarcane is mainly associated with enhanced uptake of N, P and K (Nasir et al., 2000). N, P and K are essential nutrient elements that contribute to optimum sugarcane yield and uptake (Morris et al. 2002). N, P and K application beyond 100 percent of the recommended dose produce only marginal increase in cane and sugar yield (Alexander et al., 2003). The use of nitrogen, phosphorous and potassium fertilizers play key role in development of cane and sugar yields, because sugarcane is known as a heavy feeder crop that depletes the soil of essential nutrients and therefore, adequate nutrient addition is of utmost importance (Korndorfer, 1990). The average yield of the sugarcane varieties is much lower than their potential yield. For instance, through application of balanced NPK fertilizers, the potential yields are obtained upto 165.176 t ha⁻¹ (Khan et al., 2002). Fertilizer use for sugarcane cultivation in Pakistan is imbalance and inappropriate; only 4 percent of the cane growers use NPK and 73 percent of them rely only on NP fertilization (Karstens et al., 1992). Proper fertilization is an important management function in sugarcane production (Khan et al., 2005). Therefore, it is necessary to supply sugarcane crop with the big three (N, P and K) to secure good cane quantity and quality (Elamin et al., 2007). With these ideas in view, an experiment was conducted to study the effect of trash mulch and N levels on growth, cane yield and recovery of sugarcane variety Thatta-10.

MATERIALS AND METHODS

The experiment was laid out at the experimental fields of Sugarcane Section, Agriculture Research Institute, Tandojam in a three replicated Randomized Complete Block Design having plot size of 14m x 3m (42m²). A good seedbed was prepared adopting recommended land preparation practices. Ridges were prepared to place the seed sets by end-to-end method. Trash mulch was used in all the treatments except the control, while N was applied at different rates i.e. 225, 250, 275 and 300 kg ha⁻¹ in the form of urea (46% N). The trash mulch was used to cover the surface when the germination of planted crop was completed. The mulching was practiced in such a way not to hurdle the sprouting of the seedlings. The P and K fertilizers were applied at the rates of 120 kg and 100 kg ha⁻¹. All P and K and 1/3rd of N was applied at planting time and remaining N in two equal doses at first earthing (3-1/2 months after planting) and 1-1/2 month after first earthing respectively.

Cane length: Cane length was recorded at the field in the labelled sugarcane plants by measuring tape from bottom of the cane upto the last internode in centimetres and averaged.

Cane girth: Cane girth was measured in each plot on the basis of randomly selected (tagged) plants by means of Vernier Caliper in centimetres and average was worked out.

Internodes cane¹: Internodes cane¹ were counted from the bottom of the cane upto the last internode for all the tillers in each plant in each labelled plant in each treatment plot and averaged.

Cane yield ha⁻¹(mt): The cane yield ha⁻¹ was calculated on the basis of following formula:

\[
\text{Yield plot}^1 \text{of given treatment} = \frac{\text{Cane yield (m.t ha}^{-1}) \times 10000 \text{ Plot area (m}^2) \}
\]

Sugar recovery (%): Polarity was determined by the procedure and method described in laboratory manual for Queensland sugar mills (Anonymous, 1970) in order to calculate Pol, CCS and recovery.

The data on the above characters will be collected and subjected to statistical analysis. Analysis of variance and mean separation tests will be applied (Steel et al. 1997).

RESULTS AND DISCUSSION

Germination (%)

Seed germination influences the crop production significantly; the results in regards to cane length percentage of sugarcane variety Thatta-10 as affected by trash mulch and various N levels (Table-1) indicated that highest cane length (64.00%) was recorded in plots with trash mulch + 250 kg N ha⁻¹, while the cane length was 59.00, 54.00 and 51.00 percent in case of control (no
much), mulch + 275 kg N ha\(^{-1}\), and mulch + 225 kg N ha\(^{-1}\) N, respectively. The lowest cane length (48.00\%) was recorded in plots receiving trash mulch + 300 kg ha\(^{-1}\) N. This indicates that there was no linear impact of mulching or N application levels on the cane length of sugarcane. However, the differences in cane length were statistically significant (P<0.05). These results are further supported by Tan (1995) who have reported positive impacts of mulching on germination, and Kanchann (2009) reported that increasing N rates although affects the growth and yield of sugarcane, but germination has little association with top dressing of fertilizers.

### Cane length (cm)
Cane length is a major growth and yield component in sugarcane and it has direct effect on the crop yields. The data in relation to cane length of sugarcane variety Thatta-10 as influenced by trash mulch + different N levels (Table-1) suggested that highest cane length (248.33 cm) was recorded given trash mulch + 300 kg N ha\(^{-1}\), while the cane length slightly reduced to 248.00 and 246.00 cm when the surface was covered with trash mulch and fertilized with 275 kg N ha\(^{-1}\) and 250 kg N ha\(^{-1}\), respectively. The crop treated with trash mulch + 225 kg N ha\(^{-1}\) resulted in average cane length of 236.33 cm, while the minimum cane length of 232.33 cm was achieved from the plots given N @ 225 kg ha\(^{-1}\) and no mulching (control). This indicates that mulching affected cane length significantly (P<0.05), while the differences in cane length of the crop receiving N @ 250, 275 and 300 kg ha\(^{-1}\) were statistically non-significant (P<0.05), suggesting that N application beyond 250 kg ha\(^{-1}\) would be uneconomical and excessive. Similar results have also been reported by Dahiya and Malik (2000) who found considerable increase in cane length due to mulching, while Basanta et al. (2003) reported that higher NPK levels increase cane length significantly.

### Cane girth (cm)
Cane girth is also one of main yield traits and the results on this character of sugarcane variety Thatta-10 as influenced by trash mulch + different N levels are presented in (Table-1). It is evident from the results that maximum cane girth (2.67 cm) was observed in plots given trash mulch + 250 kg N ha\(^{-1}\), while the cane girth decreased to 2.38 and 2.36 cm when the surface was covered with trash mulch and fertilized with 225 kg N ha\(^{-1}\) and 275 kg N ha\(^{-1}\), respectively. The crop treated with trash mulch + 300 kg N ha\(^{-1}\) resulted in average cane girth of 2.31 cm, while the minimum cane girth of 2.26 cm was achieved from the plots given N @ 225 kg ha\(^{-1}\) and no mulching (control). This suggested that mulching produced positive and significant (P<0.05) impacts on cane girth (P<0.05), while with increasing N level beyond 250 kg N ha\(^{-1}\) the cane girth consecutively decreased under N application of 275 and 300 kg ha\(^{-1}\). This clearly indicates that regardless the mulching practice; 250 kg N ha\(^{-1}\) would be an optimum level for obtaining maximum cane girth in variety Thatta-10. The results of the present study coincides those achieved by Rana et al. (2003) who found that cane girth is positively influenced by the mulching, because mulching conserve moisture and nutrients and suppresses weeds. Similarly, Rita et al. (2003) reported that although higher N levels improve cane girth but if N is applied at excessive rate, the cane length may increase, but cane girth will follow adverse trend.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatments (Mulch + N)</th>
<th>Germination %</th>
<th>Cane length (cm)</th>
<th>Cane girth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control (No much: 225 kg ha(^{-1}) N)</td>
<td>59.00 b</td>
<td>232.33 b</td>
<td>2.26 c</td>
</tr>
<tr>
<td>2</td>
<td>Mulch+225 kg N</td>
<td>51.00 d</td>
<td>236.33 b</td>
<td>2.38 b</td>
</tr>
<tr>
<td>3</td>
<td>Mulch+250 kg N</td>
<td>64.00 a</td>
<td>246.00 a</td>
<td>2.67 a</td>
</tr>
<tr>
<td>4</td>
<td>Mulch+275 kg N</td>
<td>54.00 c</td>
<td>248.00 a</td>
<td>2.36 b</td>
</tr>
<tr>
<td>5</td>
<td>Mulch+300 kg N</td>
<td>48.00 e</td>
<td>248.33 a</td>
<td>2.31 b</td>
</tr>
<tr>
<td>S.E.±</td>
<td></td>
<td>1.082</td>
<td>2.002</td>
<td>0.024</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td></td>
<td>3.491</td>
<td>5.746</td>
<td>0.106</td>
</tr>
<tr>
<td>LSD 0.01</td>
<td></td>
<td>5.038</td>
<td>7.544</td>
<td>0.162</td>
</tr>
</tbody>
</table>

*Pakistan Sugar Journal Jan.-Mar. 2013 (19)*
Number of internodes cane\(^{-1}\)
Number of internodes cane\(^{-1}\) is directly proportional to cane length. The data regarding the number of internodes cane\(^{-1}\) for sugarcane variety Thatta-10 as affected by trash mulch + different levels of N fertilizer are presented in Table-2. The maximum number of internodes (22.20) was recorded in crop with trash mulch + 250 kg N ha\(^{-1}\), while the number of internodes decreased to 20.43 and 20.28 when the crop was mulched with trash and fertilized with 275 kg N ha\(^{-1}\) and 300 kg N ha\(^{-1}\), respectively. The crop treated with trash mulch + 225 kg N ha\(^{-1}\) resulted in 19.00 internodes cane\(^{-1}\), while the lowest number of internodes (18.80) cane\(^{-1}\) was achieved from the plots given N @ 225 kg ha\(^{-1}\) and no mulching (control). The results clearly showed that trash mulch was effective to increase number of internodes significantly (P<0.05), while with increasing N level beyond 250 kg N ha\(^{-1}\) the number of internodes gradually reduced under N application at the rates of 275 and 300 kg ha\(^{-1}\). Regardless the mulching practice, 250 kg N ha\(^{-1}\) showed superb performance and further increase in N rate would be uneconomical for sugarcane. Most of the studies are in concurrence with the present findings. Hussain and Afghan (2001) reported that number of internodes generally is associated with genetic factors, but the internodes can be associated with cane length. In another study, Chatta (2007) found that under mulching and higher N levels, the number of internodes were increased, but this trait was generally associated with cane length.

Cane yield ha\(^{-1}\)
The results in regards to cane yield ha\(^{-1}\) of sugarcane variety Thatta-10 as affected by trash mulch + different levels of N fertilizer are presented in Table-2. The data showed that the higher cane yield of 117.67 tons ha\(^{-1}\) was achieved in crop treated with trash mulch + 250 kg N ha\(^{-1}\), while the cane yield showed adverse trend i.e. decreased to 110.33 tons ha\(^{-1}\) and 105.33 tons ha\(^{-1}\) when the crop was trash mulched and fertilized with higher N levels of 275 kg and 300 kg ha\(^{-1}\), respectively. The crop treated with trash mulch + 225 kg N ha\(^{-1}\) resulted cane yield of 109.33 kg ha\(^{-1}\), while the lowest cane yield of 92.80 kg ha\(^{-1}\) was achieved from the plots given N @ 225 kg ha\(^{-1}\) without mulching (control). The trash mulch showed significant and positive effect on cane yield (P<0.05), while increasing N levels beyond 250 kg N ha\(^{-1}\) did not show economic effects and yield decreased under N application of 275 and 300 kg ha\(^{-1}\) over 250 kg ha\(^{-1}\). Irrespective of trash mulch, 250 kg N ha\(^{-1}\) maximized the cane yield, while differences in cane yield under 275 kg and 300 kg N ha\(^{-1}\) were non-significant. These results are further supported by those of Mui et al. (1996), Yadav et al. (2009), Hussain and Afghan (2001), Chatta (2007) and Kanchann (2009) who reported that higher N levels results in increased sugar content, but its application beyond optimum level, will result in loss of sugar content. Moreover, the findings also suggested that organic mulches are economical and effective to improve sugar recovery.

Sugar recovery
The data pertaining to sugar recovery of variety Thatta-10 as influenced by trash mulch + different levels of N fertilizer are shown in Table-2. The results showed that the highest sugar recovery of 10.90 percent was noted in crop treated with trash mulch + 250 kg N ha\(^{-1}\), while the sugar recovery followed a negative direction i.e. 10.58 and 10.43 percent when the crop fertilized with higher N levels of 275 and 300 kg ha\(^{-1}\), respectively. The crop treated with trash mulch + 225 kg N ha\(^{-1}\) resulted sugar recovery of 10.78 percent, while the sugar recovery under control treatment was 10.51 percent. This indicated that increasing N levels although improved the plant growth slightly, but due to excessiveness of N, the recovery started decreasing when applied beyond 250 kg ha\(^{-1}\). Statistically, the differences in recovery between N levels of 275 and 300 kg ha\(^{-1}\) was non-significant (P>0.05) and significant (P<0.05) when compared with rest of the treatments. The present findings are in accordance with those of Mui et al. (1996), Yadav et al. (2009), Hussain and Afghan (2001), Chatta (2007) and Kanchann (2009) who reported that higher N levels results in increased sugar content, but its application beyond optimum level, will result in loss of sugar content. Moreover, the findings also suggested that organic mulches are economical and effective to improve sugar recovery.
Table-2  
Effect of trash mulch + nitrogen levels on number of internodes, cane yield and CCS of sugarcane variety Thatta-10

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Treatments (Mulch + N)</th>
<th>No. of internodes cane(^1)</th>
<th>Cane yield (tons ha(^{-1}))</th>
<th>C.C.S. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control (No much: 225 kg ha(^{-1}) N)</td>
<td>18.80 c</td>
<td>92.33 c</td>
<td>10.51 b</td>
</tr>
<tr>
<td>2.</td>
<td>Mulch+225 kg N</td>
<td>19.00 b</td>
<td>109.33 b</td>
<td>10.78 a</td>
</tr>
<tr>
<td>3.</td>
<td>Mulch+250 kg N</td>
<td>22.20 a</td>
<td>117.67 a</td>
<td>10.90 a</td>
</tr>
<tr>
<td>4.</td>
<td>Mulch+275 kg N</td>
<td>20.43 b</td>
<td>110.33 b</td>
<td>10.58 b</td>
</tr>
<tr>
<td>5.</td>
<td>Mulch+300 kg N</td>
<td>18.28 c</td>
<td>105.33 b</td>
<td>10.43 b</td>
</tr>
</tbody>
</table>

S.E.± 0.719  
LSD 0.05  1.578  
LSD 0.01  2.244

CONCLUSIONS

It was concluded that systematically applied trash mulch showed positive impact on all the studied traits of sugarcane variety Thatta-10 including cane yield and recovery. Moreover, higher N levels of 300 and 275 kg ha\(^{-1}\) slightly increases cane length, but cane girth, internodes, cane yield and recovery decreased over 250 kg ha\(^{-1}\) N level. This indicates that for obtaining economically maximum crop performance for sugarcane variety Thatta-10, the sugarcane may be trash-mulched and N may be applied at the rate of 250 kg ha\(^{-1}\).

REFERENCES

Asia Naheed & Saadia Rizwana

Chrysoperla carnea (Green Lacewing) (Predator)

Natural Enemy of Crop Pests

Biocontrol Lab (Chrysoperla carnea) at Shakarganj Sugar Research Institute

Introduction
Shakarganj Sugar Research Institute has established a Biocontrol Laboratory of Chrysoperla carnea in 2003 to control the sugarcane Pyrilla perpusilla. Under laboratory conditions C. carnea is mass multiplied by using eggs of stored grain pest (Sitotroga cerealella) as a host. Adult of Chrysoperla feed by artificial diet and larvae reared on eggs of S. cerealella. C. carnea layed green eggs on hard paper sheets which is collected and stored at 6-8°C and then release immediately in field. Chrysopa sheets produced every year for reducing pest populations below the economic injury level. These predators need to have a wide range of prey. They destroy large numbers of prey quickly.

Predators
A living organism that feeds upon other organisms that are smaller and weaker than itself.

What to look for

Chrysoperla carnea are used worldwide as highly effective biocontrol agent. She lays green eggs in the hundreds, each atop a vertical, hairlike stalk; and each egg produces a killing machine—a larva—that will eat hundreds of insects pests before it pupates in a small, parchment-like cocoon. The larvae, which are very active, are gray or brownish and alligator-like with well-developed legs and large pincers with which they suck the body fluids from prey. Larvae grow from <1 mm to 6-8 mm.

Appearance
Adult green lacewings are pale green, about 12-20 mm long, with long antennae and bright, golden eyes. They have large, transparent, pale green wings and a delicate body. Oval shaped eggs are laid singly at the end of long silken stalks and are pale green, turning gray in several days.
Life Cycle of *Chrysoperla carnea*

**Pests Attacked**
Eggs and nymph of sugarcane Pyrilla *perpusilla*. Several species of aphids, spider mites (especially red mites), thrips, whiteflies, mealybug, eggs of leafhoppers, moths, and leafminers, small caterpillars, beetle larvae, and the tobacco budworm are reported prey.

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**Recommendations**

**Application**
As and wherever desired sheets are taken to the field and punched on the under side of the leaves to avoid the direct exposure to sun. It's best to start early in the season. In field eggs hatch after 2-3 days and search for the pest. They'll search almost 100 feet for their first meal. During the 2-3 weeks it takes lacewings to develop through the larval stage, they'll eat up to 200 aphids or other insect eggs, larvae, and adults a week.

i) Lacewing release rates range from 4-5 Sheets per acre, depending on infestation levels. After emergence the larvae seek out the target pests.

ii) It's best to start early in the season, then make repeat releases every 2-3 weeks, increasing quantities as more pests appear.

iii) Once the peak pest infestation period has passed, releases can be decreased and eventually stopped.

**Precautionary Measures**
1. Observe field carefully prior to release sheets that there is no dangerous chemical in field.
2. Handle the *Chrysopa* Sheets very carefully while shifting from Lab to Field.
3. If it's inconvenient to release them immediately, lacewing eggs may be refrigerated for a few days at 6-8°C. to delay hatching, but be careful not to freeze them.
4. Don't press the sheets if the eggs damage, than emergence of larvae will not took place.

**Advantages**
1. Biological control methods can reduce the legal, environmental, and health hazards of using chemicals in the garden.
2. Biological control measures can actually prevent economic damage to the plants.
3. People, animals, or helpful insects may be completely unaffected or undisturbed by their use.
4. Biological control is also safe for the users, the farming community and to the environment.
5. Can play a key role in integrated Pest management.

**Crops Protected**
Sugarcane, Cotton, sweet corn, potatoes, cole crops, tomatoes, peppers, eggplants, asparagus, leafy greens, apples, strawberries, gardens and orchids.
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OUR MAIN LINE OF MANUFACTURING

BAGGING HOUSE EQUIPMENTS:-
• Wet & Dry Sugar Elevator
• Fluid Bed Sugar Dryers
• Sugar Graders 2 & 3 Deck System
• Sugar Grader Hopper Type

WATER TREATMENT EQUIPMENTS:-
• Water Softening Plant
• Cooling Tower
• Spray Ponds
• Water Spray Pump

MATERIAL HANDLING EQUIPMENTS:-
• Wooden Slate Type Conveyor
• Belt Conveyor
• Screw Conveyor

SPRAES FOR MILL EQUIPMENTS:-
• Chain Sprockets (Single, Duplex & Triplex)
• Worm & Worm Wheel
• Chains all Type

BAG HANDLING EQUIPMENTS:-
• Mechanized Total Conveyor’s System Chain & Belt Type for Bagging
• Houses and Godowns
• Sugar Bag Stacker with Pilot Conveyor
• Bag Sewing Machine Conveyor

PUMPS:-
• Molasses, Massecuite, Magma, Centrifugal & Non Clogging Pumps

REDUCTION GEAR BOX 5 HP TO 500 HP:-
• Helical Type Parallel Shaft, Angular Shaft Type & Worm Gears

CANE HANDLING & MILL HOUSE EQUIPMENTS:-
• Cane Cutter & Cane Leveler
• Cane Tippers (Rectangular Table & Rotary Feeding
• Table) with Hydraulic Power Pack Units
• Shredded cane belt Conveyors
• Magnet Conveyors

• Complete intermediate Carriers with Donally Chute
• Cush Cush Conveyor
• DSM Screen s
• Cane Cutting Knifes

BOILER HOSE EQUIPMENTS:-
• Induced Air & Forced Draft Fans for Boiler
• Bagasse Feeders for Boilers
• Rotary Valves for Ash Removing
• Complete Bagasses Conveyors

BOILER HOUSE EQUIPMENT (REFINERY)
• Pressure Filters 900 Sq Ft to 1500 Sq Ft Capacity.
• Cane Mud Vacuum Filters
• Muddy Juice, Raw juice. Refine Juice, Liquor Pumps
• Magma Pump with Single & Double Rotor
• Gear Pump for A & B
• Magma Mixtures, Pug Mills Sugar Remelters
• Air Cooler & Vacuum, water Cooled Crystallizers
• Duplex Valves & Steam Valves
• Gross Hoppers
• Steam trap 3” 4” 5” & 6” Sizes (Float Type)
• Rack Type Elevator for Lime
• MOL Vibrating Screen
• Masscuite Re-Heater
• Multi Jet Condenser
• Talo Flock Deep Bed Filter

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• Fans, Cyclones, Rotary Valves, Dust Collectors
• Cylone Separators, Bag Filters

FABRICATION FAQUTIES:-
• Light & Heavy Steel Structure Fabrication jobs

ERECTION FACILITIES:-
• We Undertake full Jobs on Turn Key Basis also

PAVING A WAY FOR SELF – RELIANCE
SUGAR INDUSTRY ABSTRACTS

*Shahid Afghan & Pervez Akhtar
*Shakarganj Sugar Research Institute, Jhang, Punjab, PAKISTAN

Sugarcane root system depth in three different countries
J.L. Chopart, M.C.B. Azevedo, L. Le Mézo and D. Marion,

The sugarcane root system depth is crucial as it determines the potential depth of soil available for water and nutrient uptake by the crop. It was reported in an early publication that these roots could grow quite deep (6 m), but otherwise very little data are available on the root system depth. The present study was carried out in three countries: Côte d’Ivoire (var. NCo376), Brazil (var. RR72545) and Réunion, France (var. R570) at various sugarcane growth stages. There were no shoot or root growth constraints (deep soil with enough water). For plant cane, the root front growth (RF in cm) was linear. In Côte d’Ivoire, from 45 to 160 days after planting (DAP), RF = 0.81 DAP; \( R^2 = 0.91 \). On the island of Réunion, from 100 to 280 DAP, sugarcane root front growth was: RF = 0.56 DAP; \( R^2 = 0.70 \). When DAP was replaced by thermal time (TT: sum of degree-days), the root front growth patterns were quite similar in Réunion and Côte d’Ivoire (RF = 0.045 and 0.049 TT, respectively). In ratoon conditions, RF was stable when roots from the previous cycle were still in the soil at the onset of the cropping season. Thus, the observed root depth was approximately 4 m in Brazil and Réunion, even though the environment and cultivars were different. These findings showed that, when there is no marked crop growth constraint, roots of modern commercial sugarcane varieties can grow to depths of about 4 m in ratoon crops. While these values were lower than those reported in previous studies, they were higher than those generally accepted at present.

Functional relationship between sugarcane root biomass and length for cropping system applications
J.L. Chopart, M.C.B. Azevedo, L. Le Mézo and D. Marion,

Sugarcane root length density (RLD, m/m³) and root biomass are key characteristics for respectively determining: (i) the crop nutrient and water uptake capacity, and (ii) carbon partitioning in plants and balance in soil. In previous studies, often only one of these parameters was measured. It is therefore useful to link the RLD and root biomass density (RBD, g/m³) to evaluate one parameter in relation to the other. Relationships between RLD and RBD and specific root length (SRL, m/g) were studied in Côte d’Ivoire and Réunion. Mean SRLs of fine roots were independent of the root location in the soil profile and plant age but higher in Côte d’Ivoire (68 m/g, SD = 19) than in Réunion (35 m/g, SD = 10). The best fit between the RBD and RLD of thick roots was a power function (RBD = 21.3 RLD⁰.745; \( R^2 = 0.85 \)). Mean SRL was 7 m/g. When all roots were studied together, the best fit between RBD and RLD was also a power function, with little variation between the two sites or between plant and ratoon sugarcane. The fits calculated with all data except those obtained very close to the plant stem were: RLD = 85.5 RBD⁰.742 (\( R^2 = 0.88 \)) and mean SRL = 27 m/g (SD =13). Relationships between root length and biomass were neither fixed nor fully random. Due to SRL variability, it was hard to pinpoint any mechanistic links between root length and biomass. Conversely, for simple field evaluations, a rough and ready RLD estimate can be made on the basis of RBD, and vice-versa.

Opportunities and challenges for sugarcane breeding: a summary of the 9th ISSCT breeding and germplasm workshop

The 9th Sugarcane Breeding and Germplasm Workshop was held from 17 to 21 August 2009 at the Novotel Rockford Resort, Coral Coast Drive, Palm Cove, Cairns, Australia. The workshop was hosted by staff from the BSES Limited’s Meringa Experiment Station. BSES Limited, ISSCT, and the Sugar Research and Development Corporation of the Australian Government were sponsors for the workshop. The Breeding Workshop was attended by 70 delegates from different countries, and was distinguished by its scientific content, its impeccable organisation, and a great spirit of friendliness. Australia was well represented with a contingent of 20 breeders and researchers. Delegates from Argentina, Barbados, Brazil, China, Colombia, Ecuador, Fiji Islands, France, India, Indonesia, Japan, Mauritius, Reunion, South Africa, Sri Lanka, Thailand, Uganda, and USA attended. The presentations covered topics not only on breeding for sugar content but also biomass. There was an interesting analysis from an investor point of view on the advances in traditional plant breeding compared to the use of sugarcane transformation with...
novel markers for mapping and genetic diversity studies and novel techniques for sugarcane biotechnology and bioenergy use also were discussed. Finally, an analysis on genetically modified (GM) sugarcane and associated biosafety risk was included. The Workshop demonstrated that traditional plant breeding and the biotechnology tools should work together in order to obtain rapid developments and increase production not only for sugar but also for bioenergy.

Overview of sugarcane breeding in mainland China

This paper briefly reviews the history of sugarcane breeding in mainland China, major sugarcane research institutes in different provinces, and the development and adoption of new varieties in the past 10 years. It also highlights important benefits and progress in introducing sugarcane varieties from overseas and Taiwan, China. Progress in utilising basic germplasm for sugarcane improvement in mainland China is also briefly reviewed. Challenges facing sugarcane breeding in China and potential ways to address these are proposed.

Effects of insecticides on migdolus fryanus westwood (Coleoptera: Cerambycidae) infestations and sugarcane yields

The destruction of root system by Migdolus fryanus Westwood (Coleoptera: Cerambycidae) larvae reduces the yield and the longevity of sugarcane crops. Because of this damage, this insect is one of the most important pests of sugarcane in São Paulo State, Brazil. The present study was conducted to evaluate insecticide efficacy, when applied: a) at a depth of 40 cm, using ploughshares, during the land preparation prior to planting; b) in the furrows, at planting; and c) both at 40 cm and in the furrows. The experiment was carried out at the Santa Rita Sugar Mill, São Paulo, Brazil, using a randomised complete block design with 16 treatments (insecticides applied in the furrow and/or at 40 cm, and an untreated check) and 4 replicates. Sugarcane was planted in plots with five 15 m rows spaced 1.40 m apart, in March 2007. The pest populations were evaluated in periodic samplings and, on November 2007, when there was a flight of adults in the experimental area. The highest yields were observed in plots treated with endosulfan or fipronil. The treatments applied at 40 cm were more effective than the application of insecticides in the furrows. Fipronil or endosulfan applied at 40 cm, with or without additional insecticides in the furrows, increased yields by more than 25% over the untreated check.

Effect of insecticides applied at sugarcane planting on sphenophorus levis vaurie (coleoptera; curculionidae) control and on the yield of first two harvests

Recently, the occurrence of sugarcane fields severely damaged by Sphenophorus levis Vaurie (Coleoptera; Curculionidae) has increased in the Central-South region, the main area where sugarcane is grown in Brazil. The pest management program includes mechanical destruction of infested ratoons, which often is not enough to maintain the populations below economic injury level. The use of insecticides is therefore necessary. The objective of the present work was to evaluate the effect of insecticides applied at sugarcane planting on the pest control and on the yield of the first two harvests. Three experiments were conducted as random block designs with six replicates. In addition to an untreated check, the following treatments were evaluated: carbofuran 2100 g/ha a.i., fipronil 200 g/ha a.i., carbofuran 2100 g/ha a.i. + fipronil 200 g/ha a.i., imidacloprid 960 g/ha a.i., thiamethoxam 375 g/ha a.i. and bifenthrin 250 g/ha a.i. S. levis infestations and associated plant injury were evaluated by periodic samplings. Yield data were recorded for the first two harvests. No differences between the treatments and the untreated check in relation to pest population and injury were observed. However, the treatments with fipronil, imidacloprid and thiamethoxam were associated with significant yield increases for both harvests. Considering the two harvests, these increases reached 52.2 to 69.0 t/ha or 25% of yield, suggesting that these treatments can be useful in an integrated management program.

The effect of orange rust (puccinia kuehni) on sugar yield in six sugarcane varieties in Guatemala

A replicated field trial was conducted to estimate the effect of orange rust (caused by Puccinia kuehnii) on yield in six sugarcane varieties in a plant cane crop in Guatemala. CP72-2086 is the leading variety in Guatemala constituting 57% of the crop in the 2007–08 harvest season. The other varieties (CG96-135, SP79-2233, CP88-1508, CP89-2143 and PR75-2002) showed symptoms of orange rust in September 2007 when the disease first appeared. The experimental design of the field trial was a split plot in a complete randomised block design.
where the main plot was variety and the sub plot fungicide treatment (treated with the fungicide Alto® (Cyproconazole) at a dose of 500 mL per ha) or untreated. The susceptible variety SP79-2233 was planted on each side of the trial and around individual plots as a natural P. kuehnii inoculum source. Orange rust severity in fungicide treated and untreated plots were recorded monthly from three to nine months crop age. Cane yield components (plant height, stalk diameter and stalk population) and cane weight per plot were used to estimate cane yield in tonnes of cane per hectare (TCH); sucrose concentration (Pol % cane) was also assessed at harvest. Yield losses were estimated using a regression of orange rust severity on yield (tonnes sugar per ha, TSH) for the variety CP72-2086. Data suggest that orange rust may reduce sugarcane yields in five of the six varieties. Losses in CP72-2086 were 7.67% (TCH), 8.61% (Pol % C) and 15.78% (TSH), with the regression equation $y = 20.3 - 0.2x$. The highest orange rust severity occurred at five to six months crop age in all varieties and symptoms were observed through to plant maturity.

**Advances and challenges in sugarcane biotechnology and plant pathology: a review of the ix plant pathology workshop and vi molecular biology workshop**


For the second time, the International Society of Sugar Cane Technologists (ISSCT) pathology and molecular biology workshops were jointly held, from 23–27 June 2008 in Cali, Colombia. The meeting was hosted by CENICAÑA and organised by Jorge I. Victoria and Jershon López-Gerena. The response of participants was positive with 44 delegates representing 15 countries attending. Thirty seven oral presentations and ten posters covering a wide range of topics including molecular characterisation of yeasts, insect pests and pathogens, genetic transformation of sugarcane, molecular markers, genetic mapping, pathogen variability, disease diagnosis, plant resistance and disease epidemiology among others were presented. The workshop also provided the opportunity to listen to three plenary talks on biofuel production, transgenics and nutritional improvements in food crops through genomics. A special session was devoted to orange rust, a newly introduced disease in Florida and in Central America. Following the technical sessions, site visits were organised during two days to sugar mills, commercial fields, plots with transgenic sugarcane, and laboratories at CENICAÑA. The experience of having joint-section meetings proved very useful with excellent interaction among participants.

**Productive diversification from sugarcane lignocellulosic byproducts**


The actual process of sugar and ethanol production in Mexico only uses the carbohydrates in the sugarcane juice and molasses. The remaining material, trash, bagasse and pith, constitutes the lignocellulosic byproducts (biomass) of this industry. In this work, three production alternatives were investigated: edible mushroom Pleurotus ostreatus, pulp and paper and fermentable sugar productions from sugarcane biomass. The characterisation of byproducts was carried out according to AOAC test. For the case of mushroom production, sugarcane trash and a 50:50 mixture of trash and bagasse showed the highest yields (biological efficiencies) of 106% and 103% respectively. For acid hydrolysis, trash samples generated in the local industry were used. Several tests were performed to obtain the maximum production of fermentable sugars using diluted H2SO4 at concentration level of 1.0%, temperatures (80–160°C) and hydrolysis times (0 to 330 minutes). A pseudo first-order kinetic model was developed to explain the hydrolysis from sugarcane trash using sulfuric acid. In the last alternative, bagasse pulping and ECF Bleaching (elementary chlorine free) were analysed in detail using TAPPI standards to establish the optimum pulping conditions for this lignocellulosic material.

**Biodiesel starting from non edible oils and ethanol for self-consumption in the agro industrial production of sugar and other foods**


The decrease of fossil fuels in the near future and climate change constitute the main drivers at the present time for the development of biofuels. They are doubly relevant to the sugar industry because it is a consumer of fuels as well as a potential producer. This paper shows the results of an experimental preliminary study with oleaginous plants, which can be cultivated in soils unsuitable for the production of food, with high yields of around 1 t/ha. Experiences of the synthesis of fuel from such oil and ethanol are
reported, which turn out to be somewhat complex but allow the production of biodiesel starting from totally renewable sources with important environmental advantages. An example is shown in which it is possible to achieve biodiesel production to substitute for the consumption of all agricultural diesel by using a small percentage of the land belonging to a farm complex for the production of sugar and other foods. Results for the use in cane transport, at mixtures of 5, 10, 20, 50 and 100% (total substitution) of biodiesel are also presented.
INTRODUCTION
Shakarganj Foundation works in partnership with the local communities surrounding its plants to improve the quality of life of the local population. Its Social Action Program was launched as part of its endeavor to introduce contemporary healthcare services and raise education, environment and cultural awareness among the rural masses and the underprivileged.

Objectives
- To make concentrated efforts with inherent integrated approach
- To provide standard education to the students of downtrodden strata, the main hub of SF philanthropic activities
- To provide basic health facilities and launch campaigns against contagious diseases
- To promote art and preserve cultural heritage
- To conduct sports and extra-curricular activities

Certifications & Awards
- Certified by Pakistan Center for Philanthropy
- Global Compact Responsible Business Award 2009 in Large National Category
- 1st Pakistani Organization to win USD 20,000 Intel Asian Management Award
- 5th CSR National Excellence Award 2010
- Federal Board of Revenue issued Income Tax Exemption Certificate

Activities of Social Action Program
A. Adaptation of Schools
We have adopted 35 Government Girls/Boys Schools out of which 6 are Primary and 27 are Elementary Schools in 2003 to provide missing facilities i.e. Provision of uniforms, First Aid Boxes, White wash, Tree Plantation and Cleanliness Allowance. We have also conducted blood grouping, Screening and vaccination against Hepatitis “B” in all adopted schools.

New school building is being provided for the children of adjacent areas of Shakarganj Mills Limited.

Total numbers of Students who are being benefited in these Schools are 7,462

Uniforms Distribution
School Uniforms distributed in SML Colony, Shadbad Girls & Boys Primary Schools by Mr. Zahid Naseem EDO Education Jhang.

Annual Prize Distribution
To encourage brilliant students of all 35-adopted schools.
Prizes distributed among position holders in each class.
Teachers were also awarded with gift hampers.
**Tree Plantation**
Tree plantation conducted every year in adopted schools
3,000 trees planted in this spring

**Nutritional Program**
We are providing Milk and Fruit on alternate days in 2-Govt Girls Primary Schools to make up the nutritional deficiency of the Students. 225- students of both schools are being benefited by this activity since 2004

**Literacy Centers**
This activity was started in 2003 to educate the illiterates of the community, ranging between the ages from 15 to 50 years in a batch of 25-students through Jungnoo Sabaq. 130 batches of Adult Literacy Centers have been completed 3,250 students have been passed out. Recently we got USAID project for our adult female literacy program.

Ms. Staphine Mayer Rotary ambassador visited our Paccy wala Adult Female Literacy Center

**Shakarganj Sponsored TCF School**
Shakarganj has provided land and funds for the construction of two elementary schools through The Citizens Foundation (TCF) schools system. A total of 369 students are currently enrolled in these schools, located in close proximity of the factory sites in Jhang and Bhone.
School of Calligraphy and Art (Jhang Art Gallery)
Shakargarj Social Action Program has sponsored School of Calligraphy and Art in 2002 in the name of Jhang Art Gallery where matriculate students get training in Dress Designing (Cutting, Stitching and Embroidery) Fine art (Painting, Pottery, Ceramics work, Glass work and Tile Work) & Calligraphy. 450 students have been passed out in 15 batches.

Ms. Zakia Shah Nawaz, Senior Advisor to Chief Minister Punjab awarded 1st prize to our brilliant student Ms. Sadia Tabsum in dress making competition held under Punjab Youth Festival 2012 at provincial level.

Shakargarj Teachers Training and Resource Centre (TARC)
To provide backbone support to the education initiative, the Shakargarj Teachers Training and Resource Centre (TARC) was set up in 2001 and operated within the Mills’ premises. 1,427 Teachers are trained in 649 workshops with a focus on more efficiently teaching the arts and sciences as well as management and leadership skills to improve the administrative structure of these schools. 51,416 students of 1,053 have been benefited from this activity.

Scholarships
To encourage the brilliant students, Shakargarj started awarding scholarship to Matriculate and F.Sc position holders in the field of Education, since 2002. Financial assistance provided to the widows of ex-employees and jobless people.

B. Health Care
Mobile Free Dispensaries
This program was started in 2003 to provide medical facility in rural areas. We have two Mobile Free Dispensaries consisting upon 2-qualified Doctors along with Paramedical Staff. These teams visit 8-Kisan Marakz twice in a week and provide free of cost medicines to the patients. 322,775/- patients have been treated till to date.

Stationed Free Dispensaries
The Foundation has initiated three permanent Free Dispensaries equipped with medical equipments and Para Medical Staff adjoining Kachi Abadi and Rural area surrounding the Shakargarj Mills Premises Jhang & Bhone to provide free basic medical facilities to deserving people. 20,559 people being benefited. In addition to this another Stationed Free Dispensary launched at Shabirabad a rural area of District Jhang. 13,737 patients were also treated free of cost in flood affected areas.

Plantation of Artificial Limbs
This program was started on February 26, 2008 with the courtesy of ICRC Azad Jammu & Kashmir. The program is aimed at providing more physically challenged persons of Jhang districts with free artificial limbs. 216 patients have been planted artificial upper and lower limbs.

Animal Vaccination
This Program was started on, March 29, 2008. 29,059 animals have been vaccinated against Black Quarter (BQ) a deadly disease in animals, in different areas of Jhang.

Annual Sports
Annual Sports are held every year in the month of February in Shakarganj Mills Colony for three days in which Male and Female students of all the Schools and Colleges of province Punjab participate. Out door and Gymkhana sports are conducted.

Prizes and Certificates are awarded to successful participants for their encouragement.
INTERNATIONAL EVENTS CALENDER

- American Society of Sugar Cane Technologists - ASSCT Louisiana Division Meeting, Louisiana, USA, February 2013
- SPRI Research Advisory and Review Committee Meeting, February 26, 2013
- SPRI Annual Meeting of the Corporation, February 26, 2013
- SPRI Board of Directors and Executive Committee Meeting, February 26, 2013
- ASSBT- 37th American Society of Sugarbeet Technologists Meeting, Anaheim, California, USA, February 27 – March 2, 2013
- 20th Carbohydrate Symposium, April 5, 2013
- 245th American Chemical Society National Meeting, April 7-11, 2013
- 3rd European Society of Sugar Technologists (ESST), May 6-8, 2013
- Sugar Industry Technologists - S.I.T., May 12-15, 2013,
- XXVIII ISSCT Congress, June 23-27, 2013, Sao Paulo, Brazil, Tranamérica Expo Center, São Paulo,
- 30th International Sweetener Symposium, Silverado Resort and Spa, August 2-7, 2013
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Shakarganj Sugar Research Institute
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THE STORY OF SWEETS

1. Zarda Sweet Saffron Rice

Ingredients
Sehla rice (soaked) 2 cup
Sugar 1 cup
Dried whole milk 250 gm
Compote 100 gm
Clarified butter 6 tbsp
Cinnamon 3 sticks
Cloves 5
Yellow food coloring 1 pinch
Screwpine few drops
Dried fruit as required

Cooking Directions
1. Put a cup of water in a pot and add 1 cup sugar to it.
2. Cook it on high flame for 5-7 minutes to make sugar syrup.
3. Heat clarified butter in a separate pot, add cinnamon and cloves to it.
4. When it starts to give a fragrance, add rice that has been soaked for at least 2 hours and equal amount of water.
5. Cover the pot with a lid.
6. When rice starts to dry, add sugar syrup and half the dried whole milk.
7. Add half the compote and a few drops of screwpine to the rice.
8. Cover the pot with a lid.
9. Add food coloring.
10. When the sugar syrup starts to dry, cover tightly and cook on very low steam for 10 minutes.
11. Take Zarda out in a dish, garnish with the remaining dried whole milk, compote and dried fruits before serving.

2. Jalebi

Ingredients
White flour ½ kg
Sugar 1 kg
Food color 1 pinch
Yeast 1 tbsp
Kewra essence few drops
Milk as required

Cooking Directions
1. For syrup:
2. Pour water in a wok and boil it.
3. Then add sugar in it and cook it till it dissolves.
4. Now add kewra essence in it.
5. Syrup is ready.
6. For jalebi preparation:
7. In 1 cup warm water add and mix sugar and yeast and leave it for a while.
8. Now take a bowl add white flour, yeast, food color and milk to make batter and leave it for 2 hours.
9. Now blend it well.
10. Now heat up oil in a pan, now pour batter slowly and make ring shape from the batter and fry it then one by one dip it in syrup for a while and take it out.
11. Jalebi is ready.
SUGAR AND HEALTH NOTES

CONSUMER UNDERSTANDING OF SUGARS CLAIMS ON FOOD AND DRINK PRODUCTS

N.J. Patterson*, M.J. Sadler^ & J.M. Cooper±
*Leatherhead Food Research, Leatherhead, UK;
^MJSR Associates, Ashford, UK; ±British Sugar PLC, Peterborough, UK


Abstract
Consumer understanding of nutrition and health claims is a key aspect of current regulations in the European Union (EU). In view of this, qualitative and quantitative research techniques were used to investigate consumer awareness and understanding of product claims in the UK, focusing particularly on nutrition claims relating to sugars. Both research methods identified a good awareness of product claims. No added sugars claims were generally preferred to reduce sugars claims, and there was a general assumption that sweeteners and other ingredients would be added in place of sugars. However, there was little awareness of the level of sugar reduction and the associated calorie reduction in products when reduced sugars claims were made on pack. In focus groups, participants felt deceived if sugar reduction claims were being made without a significant reduction in calories. This was reinforced in the quantitative research which showed that respondents expected a similar and meaningful level of calorie reduction to the level of sugar reduction. The research also identified consumer confusion around the calorie content of different nutrients, including over-estimation of the calorie content of sugars. This is crucial to consumers’ expectations as they clearly link sugar to calories and therefore expect a reduction in sugar content to deliver a reduction in calorie content.

REDUCTION IN ENERGY INTAKE, NOT MACRONUTRIENT COMPOSITION, MOST IMPORTANT DETERMINANT OF FAT LOSS

Russell J de Souza, George A Bray, Vincent J Carey, Kevin D Hall, Meryl S LeBoff, Catherine M Loria, Nancy M Laranjo, Frank M Sacks, and Steven R Smith Department of Nutrition, Harvard School of Public Health, Boston, MA and Endocrine Division, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA.


Abstract
Background: Weight loss reduces body fat and lean mass, but whether these changes are influenced by macronutrient composition of the diet is unclear.

Objective: We determined whether energy-reduced diets that emphasize fat, protein, or carbohydrate differentially reduce total, visceral, or hepatic fat or preserve lean mass.

Design: In a subset of participants in a randomized trial of 4 weight-loss diets, body fat and lean mass (n = 424; by using dual-energy X-ray absorptiometry) and abdominal and hepatic fat (n = 165; by using computed tomography) were measured after 6 mo and 2 y. Changes from baseline were compared between assigned amounts of protein (25% compared with 15%) and fat (40% compared with 20%) and across 4 carbohydrate amounts (35% through 65%).

Results: At 6 mo, participants lost a mean (±SEM) of 4.2 ± 0.3 kg (12.4%) fat and 2.1 ± 0.3 kg (3.5%) lean mass (both P <0.0001 compared with baseline values), with no differences between 25% and 15% protein (P ≥ 0.10), 40% and 20% fat (P ≥ 0.34), or 65% and 35% carbohydrate (P ≥ 0.27). Participants lost 2.3 ± 0.2 kg (13.8%) abdominal fat: 1.5 ± 0.2 kg (13.6%) subcutaneous fat and 0.9 ± 0.1 kg (16.1%) visceral fat (all P <0.0001 compared with baseline values), with no differences between the diets (P ≥ 0.29). Women lost more visceral fat than did men relative to total-body fat loss. Participants regained ~40% of these losses by 2 y, with no differences between diets (P ≥ 0.29). Weight loss reduced hepatic fat, but there were no differences between groups (P ≥ 0.28). Dietary goals were not fully met; self-reported contrasts were closer to 2% protein, 8% fat, and 14% carbohydrate at 6 mo and 1%, 7%, and 10%, respectively, at 2 y.

Conclusion: Participants lost more fat than lean mass after consumption of all diets, with no differences in changes in body composition, abdominal fat, or hepatic fat between assigned macronutrient amounts.
GROWER’S CORNER

Identification and Prevention of Sugarcane from Frost or Freeze Damage

Syed Zia-Ul-Hussnain and Aamir Shahazad

An informal observation was recorded on sugarcane freezing-frost damage during 2005-2011 in the months of December-January every year. The temperature during these months reached as low as 0 to -3.0 °C in sugarcane growing areas of the Punjab Province, Pakistan. The sugarcane crop damage by frost or freeze was recorded from 70 to 90 % of total stand crop in Punjab. Weight loss in sugarcane due to frost or freeze was 10-25 % and decrease in sugar recovery was 1.23 % to 2.0 %. Again this year we have been experiencing some very cold weather almost every night.

So first let’s understand the difference between frost or freeze damage.
Frost damage in plants, results the liquid inside individual cells freezing and forming ice crystals. The crystals then rupture the cell walls, causes the leaf burn and death of the growing point. Freeze damage occurs when temperatures sustain between 0 to -3.8 °C. Freezing temperature damage to the terminal buds and cause leaves to brown (Fig-1) but no stalk tissue is damaged and no deterioration takes place. When temperature ranges between -2.0 to -4.0 °C kill buds and internal stalk tissue (Fig-2).

The effects of frost or freeze damage on sugarcane crop.
Freezing temperatures kill all above-ground parts of the sugarcane crop and also produce freeze cracks on the crop plants. Due to the freeze injury, dead and dying cells are vulnerable to invasion by the bacterium Leuconostoc mesenteroides. This bacterium is found everywhere in cane fields. The bacteria enter into the tissue through dead lateral buds and cracks. Fermentation process is started after the entrance of the bacterium (Fig-3). Bacteria consume sucrose from the stalk tissue and produces dextran which reduce the weight of the crop and sugar recovery %. Dextrans are polysaccharides have a high molecular weigh. For the sugar manufacture, dextran is a problem which changes the quality of sugar and the industry efficiency.

How, we can protect the sugarcane crop from frost or freeze damage.
1. Proper crop management though out crop growing season.
2. Use of recommended fertilizer at proper crop stage.
3. Application of light and frequent irrigation during frost period.
4. Burning of trash and rubbish material to produce smoke near around crop field.
5. Avoid inter culture operations in autumn planted cane crop during frost period.
6. Practice inter-cropping of brassica, maize and fodder.
7. Cultivation of early maturing sugarcane varieties in frosting area.

Fig.1 Brownish leaves appearance  Fig.2 Damage of internal stalk tissue  Fig.3 Reddish color of the vascular tissue
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