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Contents

WATER QUALITY OF TUBE WELLS LOCATED IN SUGARCANE CULTIVATED AREAS OF SARGODHA AND JHANG DISTRICTS

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ABSTRACT

A study was undertaken in Sargodha and Jhang districts to categorize suitability of tube well water for irrigation. In total, 55 water samples were collected in different localities: 14 from Sargodha and 41 from Jhang district. The samples were analyzed for electrical conductivity (EC), sodium adsorption ratio (SAR), residual sodium carbonate (RSC) and boron (B). With respect to EC it was found that 28 % samples in Sargodha and 44 % samples in Jhang district were marginally fit to unfit for irrigation purpose. With respect to SAR, 14 % samples at Sargodha and 24 % samples at Jhang were marginally fit to unfit respectively. Based on RSC value 36% samples at Sargodha and 37 % samples at Jhang were marginally fit to unfit for irrigation. On the combined basis of three parameters, only 14.3 % tube well water samples at Sargodha and 17.1 % samples at Jhang were unfit for irrigation. In tube well water Boron was found 2-3 times more than canal water. It can be concluded that brackish water should be used through proper treatment for crop production especially sugarcane. Boron should only be applied on recommendation.

Key words: Tube well water, Sargodha, Jhang EC, SAR, RSC, Boron

INTRODUCTION

Pakistan has the largest contiguous gravity flow canal system for irrigation, also supplemented by pumping ground water. Due to scarcity of canal water the dependency on the ground water is increasing day by day. Thirty five percent of agricultural water requirements in Pakistan are presently met from groundwater and most of the drinking water supplies are also drawn from groundwater. The number of existing private tube wells in Pakistan is over 600,000. The rate of increase is 20,000 tube wells per year. The discharge of the private well functioning tube wells is 0.8 cusec (23 l/sec) (Bhutta and Alam, 2005). Studies have shown that due to use of groundwater, yields of crops have increased 150-200 percent and cropping intensities have increased from 70 to 150 percent (Qureshi, 2004).

Quality of water is of immense importance because poor quality of both surface and ground water is not only a limiting factor in crop production but also its constant indiscriminate use causes secondary salinization. The extent and nature of salt accumulation and the degree of soil alkalinity depends on the quality of irrigation water. To avoid indiscriminate use of ground water, proper management practices are deemed necessary keeping in view the crops to be grown and the soil to be used. The water quality research is also needed to develop management (Pervaiz *et al*., 2003).

Conventionally irrigation water quality is assessed from the values of EC for total soluble salts and by SAR and RSC for sodicity hazards. EC is a measure of the amount of total soluble salts. Salts in soil or water could reduce water availability to crops to affect lower yields. SAR is a measure of sodicity hazard of irrigation water due to low Ca^{2+} + Mg^{2+} or high Na, concentration. High SAR includes soil dispersion and structural deterioration leading to infiltration problems, specific ion toxicity, nutrient deficiency or toxicity and ultimately a reduction in crop yields. The RSC is also a measure of sodicity hazard of irrigation waters due to high

$CO_3^{-2} + HCO_3^{-}$ over low $Ca^{2+} + Mg^{2+}$. High RSC could cause Ca^{2+} and Mg^{2+} deficiency through precipitation, infiltration problems and increase soil solution SAR through promoting precipitation of $CaCO_3$ in soils (Ghafoor *et al*., 2001).

Sugarcane is a typical glycophyte exhibiting stunted or no growth under salinity with its yield falling to 50% or even more of its true potential (Subbarao and Shaw, 1985). The yield reduction of sugarcane at salinity level of 4 dS m^{-1} is estimated to about 12.5% (Maas, 1993). Salts interfere with sugar production in a two-fold manner, first by affecting growth rate and yield of cane and second by reducing sucrose content of stalk by affecting juice quality and biomass (Lingle and Wiegand, 1996; Blackburn, 1984, Nasir *et al*., 2000).

In Sargodha and Jhang districts of Pakistan, tube well water is being used alone or along with canal water for irrigation of crops especially sugarcane. Voluminous work has been done for other districts of Punjab but very little information is available for Sargodha and Jhang districts and to develop a package of technology for high crop yield using marginal quality water. Thus it is very important to ascertain the quality of tube well water used for irrigation in these districts. Keeping these facts in view a study was made with the objectives to determine the suitability of tube well waters used in Sargodha and Jhang districts for irrigation.

MATERIALS AND METHODS

In order to evaluate the quality of tube well waters, 55 water samples were collected from both Sargodha and Jhang districts. Tube well selection was made randomly in both districts. Water samples from tube wells were taken in 500 mL polyethylene bottles in the area where tube wells are being used for irrigation of sugarcane. The collected samples were analyzed within ten days of collection at Land Resources Research Programme (LRRP), Islamabad for electrical conductivity (EC) and for different cations (Ca^{++}, Mg^{+}, Na^{+}, B^{+}) and anions (HCO_3^{-}, CO_3^{2-}) (U.S. Salinity Lab. Staff, 1954). Then SAR and RSC were computed as:

$$RSC = (CO_3^{-2} + HCO_3^{-}) - (Ca^{2+} + Mg^{+})$$
$$SAR = Na^{+}/(Ca^{2+} + Mg^{+}/2)^{1/2}, \text{ all expressed as } mmol_c\ L^{-1}.$$

The main areas of water collection were Sahiwal, Sargodha and Shahpur tehsils of district Sargodha and Shorkot, Jhang and Chaniot tehsils of district Jhang. The criterion for evaluation of irrigation water was followed as given in Table-1 (Malik *et al*., 1984). All the water samples collected from the area were compared with the canal water collected from the same area.

RESULTS AND DISCUSSION

Electrical conductivity (EC)

The perusal of the data on EC (Table-2) indicates that the values at Sargodha district ranged between 0.39 to 2.38 for tube well water and between 0.22 and 0.33 dS m^{-1} for canal water. At Jhang district the value varied from 0.42 to 4.69 for tube well and from 0.20 to 0.65 dS m^{-1} for canal water. When classified on the basis of EC values the data (Table 3) showed that in Sargodha 72% of tube well samples were fit, 14% marginally fit and same were unfit for irrigation. At Jhang district 56% tube well water samples were fit, 20% marginally fit and 24% were unfit for irrigation.

It is evident from the data that canal water in both the experimental regions was fully suitable for irrigation however the case was different with tube well waters in both the districts (Tables 2-6). About 36% ground water of both the districts was marginal to unfit for irrigation. The results are in line with Khalid *et al*. (2003) who worked in Rawalpindi district and observed that EC of the most of the water samples (74%) were within the safe limits. The areas where tube well water was not fit were away from river beds or main canals. For example three samples from Sahiwal and two samples from Shahpur area were unfit which were collected from southern part of Shahpur –Sahiwal Road. Similarly 13 samples from tehsil Jhang were collected within 10 km of east-south-west of the city, four from Shorkot, two from Faisalabad-Jhang road and two from Chaniot area. In these areas careful water application should be done through mixing with canal water and maintaining leaching fraction such that salts may pass beyond the root zone.

Sodium adsorption ratio (SAR)

The data on SAR (Table-3) shows that in Sargodha district it ranged between 1.75 and 12.93 for tube well water and between 0.47 and 0.71 for canal water. At Jhang district it was from 0.28 to 8.76 for tube well and from 0.50 to 3.56 for canal water. When water samples were classified on the basis of SAR (Table-3), it appeared that in Sargodha 86% of tube well samples were fit, while 7% each were marginally fit and unfit. At Jhang district 76% tube well samples were fit while 24% marginal and none were unfit for irrigation. Some of the tube well waters had shown problem as regards SAR in both the districts. Application of gypsum or irrigation of this water through mixing with high Ca^{2+} irrigation water could be the possible way-out of combating this problem. Gypsum requirement of such irrigation waters is presented in Table-4. Similarly Ghafoor *et al.* (1991, 1997) reported irrigation water treatment and proper utilization for crop production.

Residual sodium carbonate (RSC)

The data on RSC (Table-5) ranged between nil to 7.80 $mmol_c\ L^{-1}$ for tube well water at Sargodha district and in Jhang district the RSC was up to 6.60 $mmol_c\ L^{-1}$ for tube well samples. The classification of water samples on the basis of RSC (Table-5) shows that in Sargodha 64% of tube well samples were fit, 14% were marginally fit and 22% were unfit. At Jhang district 63% tube well samples were fit, 5% marginal and 32% samples were unfit for irrigation. All the canal water samples were fit for irrigation purpose in both the districts with respect to RSC. Hence a considerable number of tube wells in both the districts had marginal to high RSC. High RSC precipitate Ca, Mg and other polyvalent cations inducing sodicity hazard and non-availability of these nutrients to the crop. It also induces Ca^{2+}-Na^{+} exchange on the exchange complex of soil resultantly sodicity is developed that create problems like soil dispersion, root impediment and reduction in water infiltration. Hence judicial management of such waters is necessary prior to irrigation. It can be managed through the application acid or gypsum as given in table-4. Gypsum application is rather easy to apply however it might decrease plant availability of a number of nutrients like P, Zn and Fe through complexing and precipitation. Hence acid like H_2SO_4 application or mixture of both should be preferred under such condition.

Classification of water samples on the basis of three parameters (EC, RSC and SAR)

Tube well waters were also classified on the combined basis of EC, SAR and RSC. Data regarding tube well water (Table-6) showed that at Sargodha 14.3 % of water samples were unfit for irrigation while at Jhang 17.1 % samples were unfit for irrigation. Such waters need special attention as they have dual nature of problem. Hence it needs combined management of dilution, chemical amendment application and leaching.

Boron concentration

The data on boron concentration (Table 7) showed that tube well water samples ranged from 0.0 to 0.29 mg L^{-1} with an average value of 0.12 mg kg^{-1} at Sargodha district while it ranged between 0.02 and 0.63 mg L^{-1} with and average value of 0.18 mg L^{-1} at Jhang district. The canal water samples ranged between trace and 0.17 mg L^{-1} at Sargodha and between 0.02 and 0.17 mg L^{-1} at Jhang. Hence tubewell water had significantly high amount of B over canal water which was in non-toxic limits according to Gupta and Yadav (1986). The experiments conducted on fertilizer management on sugarcane (Ahmad and Ejaz, 2008) suggested that B application had little or no effect on cane yield in the areas of Sargodha and Jhang districts where tube well water was applied. This suggests that for b fertilization water testing should be pre-requisite especially for tube wells otherwise it may cause toxicity to a number of sensitive crops (Eaton, 1935).

CONCLUSION

Tube well waters were unfit due to higher concentration of soluble salts (EC), sodium and RSC. Therefore, it is desirable that tube well water should be tested at installation and randomly during working. If desirable proper management practices must be adopted like application of gypsum, acid or water mixing with canal water as would be suggested by quality testing officials. Boron application should be applied only where it was suggested.

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Table-1 Criteria for evaluation of irrigation water

Criteria	**Fit**	**Marginally Fit**	**Unfit**
EC (dS m^{-1})	<1	1-1.25	>1.25
RSC ($mmol_c$ L^{-1})	<1.25	1.25-2.25	>2.25
SAR ($mmol_c$ L^{-1})	<6	6-10	>10

Table-2 Classification of water samples on the basis of EC

Districts	Type of water	Range	Average	Fit	Marginal	Unfit
		dS m^{-1}		Number (%)		
Sargodha	Tube well	0.39-2.38	0.91	10 (72)	2 (14)	2 (14)
	Canal	0.22-0.33	0.24	14 (100)	--	--
Jhang	Tube well	0.42-4.69	1.09	23 (56)	8 (20)	10 (24)
	Canal	0.20-0.65	0.42	12 (100)	--	--

Table-3 Classification of water samples on the basis of SAR

Districts	Type of water	Range	Average	Fit	Marginal	Unfit
				Number (%)		
Sargodha	Tube well	1.45-12.93	4.32	12 (86)	1 (7)	1 (7)
	Canal	0.47-0.71	0.60	14 (100)	--	--
Jhang	Tube well	0.28-8.76	4.25	31 (76)	10 (24)	--
	Canal	0.52-3.56	1.92	12 (100)	--	--

Table-4 Gypsum requirement of waters having high SAR and RSC

Location	EC	SAR	RSC	GR (kg/4-acre-inch irrigation) for		
	dS m^{-1}		$mmol_c L^{-1}$	SAR	RSC	Total
Sahiwal	1.32	12.93	7.8	78	185	263
Sahiwal	1.13	7.77	4.6	-	73	73
Khushab road Sargoda	0.75	3.56	2.8	-	10	10
Near Jhang	0.91	8.56	6.6	11	143	154
Near Jhang	1.21	8.65	5.4	14	101	114
Near Jhang	1.18	5.44	2.8	-	10	10
Sargodha road Jhang	1.02	6.44	3.4	-	31	31
Shorkot	1.68	8.66	3.8	21	45	66
Multan road Jhang	1.03	7.05	4.6	-	73	73
Toba Rd. near SML	1.3	8.76	4.2	-	59	59
Chaniot road Jhang	1.5	7.96	4	-	52	52
Bypass Jhang	1.3	5.1	2.8	-	10	10

Table-5 Classification of water samples on the basis of RSC

Districts	Type of water	Range	Average	Fit	Marginal	Unfit
		(mmol$_c$ L^{-1})		Number (%)		
Sargodha	Tube well	0-7.8	1.7	9(64%)	2(14%)	3(22%)
	Canal	nil	--	14(100%)	--	--
Jhang	Tube well	0-6.6	1.4	26(63%)	2(5%)	13(32%)
	Canal	0-1.0	0.1	12(100%)	--	--

Table-6 Classification of water samples on the basis of EC, SAR and RSC in Sargodha and Jhang districts

District	Total water sample	Fit	marginal	Unfit
	Number	Number (percent)		
Sargodha	14	7 (50)	3 (21.4)	4 (28.6)
Jhang	41	19 (46.3)	4 (9.8)	18 (43.9)

Table-7 Boron contents in different waters of Sargodha and Jhang districts

Districts	Type of water	B (mg L^{-1})		
		Minimum	Maximum	Average
Sargodha	Tube well	0.02	0.63	0.18
	Canal water	Tr.	0.17	0.09
Jhang	Tube well	Tr.	0.29	0.12
	Canal water	0.02	0.17	0.08

SWEETENING FOOD SECURITY IN BANGLADESH: PRESENT SITUATION AND FUTURE STRATEGY

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ABSTRACT

Sugar and jaggery (locally called 'gur') are the main important sources of sweetener (source of carbohydrate) in Bangladesh. Sugar is indispensable for health and if it is not taken directly, it must be taken from other sources of carbohydrates in the food. During 1990-91 to 2006-07 availability of sugar and gur in Bangladesh was 0.99 million tons on an average both from internal production and importation. During the same period mean domestic production of sugar and gur were 0.18 million tons and 0.42 million tons respectively which could meet 33% of the internal demand of sugar and gur. Deficit of demand was 0.75 million tons about 39 % of the internal demand and the rest 28% of the demand was meet by importation. Per capita availability of sugar and gur were 5.8 kg and 3.0 kg as against demand of 10 kg sugar and 3 kg gur respectively during the aforementioned period. Sugarcane cultivation area, sugarcane production and sugar production showed negative trend which were -1.06, -1.37 and -4.43% respectively whereas yield of sugarcane, gur production and importation of sugar showed positive trend which were 0.62, 0.05 and 19.33% respectively. The sugar industry of Bangladesh made losses of Tk. 461.48 million per year on an average during aforementioned period. Date palm and palmyra palm plantation in homestead, embankment, ponds, road sides, marginal lands and ail (demarcation mark) that remain fallow would be an alternative source of sugar and gur to meet up the increasing demand of sugar and gur in Bangladesh.

Key words: Date palm, food security, sugarcane, sugar, gur, demand, supply.

INTRODUCTION

The issue of food security is now not only the concern of developing countries but also the matter of whole world. Although, Bangladesh as one of the developing countries has made considerable progress in augmenting domestic production especially rice production over the past years. However, sustainability of production and hence availability of food is a big issue which is being raised very strongly recently. Bangladesh will have to produce about 35 million metric tons of food grain by the year 2020, with a reduced availability of agricultural land. If all or most of this magnitude of food will have to be produced domestically, it should be real challenges for the nation. Nutritious food is also included in the system of food security. According to FAO, food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Healthy and energetic survival in the world should be the main importance of food security than normal survival. Sweetening food is very important to become energetic and healthy. It provides instant energy to human body (carbohydrates). National nutritional level is much dependent on the consumption of sugar and gur in Bangladesh (Alam, 2008). Per capita consumption of sugar is very important in the context of health, IQ, calorie intake of the nations. Sugar is indispensable for health and if it is not taken directly, it must be taken from other sources of carbohydrates in the food. Since sugar, as it is called, a cheap source of instant energy, a person should take it liberally. According to the nutritionists (CSIR, 1957), "a person requires a minimum of 44 Ib (20 kg) of sugar or equivalent quantity of gur per year in his (or her) diet". It is believed that there is a strong positive relation between total sugar consumption and health standard of a nation. Hence, it is necessary to produce more domestic sugar and gur to maintain our minimum health standard for our growing population through the increase production of sugarcane and other allied sweetening crops in Bangladesh.

Sugar industry is the most important agro-based rural industry in Bangladesh. More than 0.6 million farm-families are dependent on sugar industry for their subsistence. But now the existence of this industry is questionable due to its huge losses each year. Currently, on an average, the principal raw materials, sugarcane, for producing sugar is growing in 0.18 million hectare of land of which almost 50% is located in the sugar mills zones, where sugarcane is mostly used for sugar production and remaining 50% is situated in the non-mill zones, where sugarcane is mostly diverted for gur and juice production (Bench mark survey of Sugarcane, 1996). Sugar industry added value to final output in the form of sugar and its by-product. Further it is value added in our national economy when the final output is marketed to the consumer via dealer (distributer, wholesaler and retailer). Therefore, there is a wide scope of increasing sugar production and its by-product through sugarcane processing which will meet up not only to growing demand of sugar but also to create enormous scope of employment in the country (Alam *et al*., 2006).

With the present population growth rate at 1.48 per cent per annum, the population will be at 20 cores in 2020 (Economic Review, 2007). At present, 15 sugar mills are in operation under BSFIC (Bangladesh Sugar and Food Industries Corporation) with a capacity of 0.20 million tons of sugar production per year. Demand of sugar and gur are being increased with population increase and urbanization, while sugarcane acreage is being gradually decreased and/or pushed to low lying marginal lands due to higher demand for cereals, vegetables etc and utilization of crop lands for houses, roads, industries etc (Alam, *et al.,* 2008). Therefore, there is little or no scope to increase both cane yield and sugarcane acreage to meet higher demand of sugar and gur for ever increasing population in Bangladesh. According to FAO recommendation, per capita at least 13 kg sugar is required for human balanced diet, and as such present requirement of sugar for 140 million populations in Bangladesh is about 1.8 million tons. Present production of sugar and gur in the country is about 0.07-0.2 million tons and 0.35- 0.5 million tons respectively, and as such shortfall of sugar/gur is about 1.38-1.1 million tons. Date palm gur may be an alternative source of sugar to supplement the increasing demand for sugar/gur in Bangladesh (Alam *et al.,* 2008). As not only sugarcane land but also total cultivable land is decreasing so it is important to find ways to meet up the escalating demand of sugar and gur and thus ensuring the availability of sweetening food in Bangladesh. So, this study has been undertaken to critically evaluate the present situation and future prospect of sugar and gur production in Bangladesh.

MATERIALS AND METHODS

All the sugar mills of Bangladesh were selected for the study. Data were collected from published sources like annual report/MIS report of Bangladesh Sugar and Food Industries Corporation (BSFIC), Bangladesh Sugarcane Research Institute (BSRI), Directorate of Agricultural Extension (DAE), Bangladesh Bank (BB) and Bangladesh Bureau of Statistics from 1990-91 to 2005-06 crushing seasons. Descriptive statistics and time series data were used to analyse the data of the study. For growth analysis exponential growth rate model was used.

$y = ae^{bt}$ or, $\log e^{y} = \log e^{a} + bt$ Where,

y = Sugarcane area, production, yield, sugar production,

t = time period, and

$e^{b} - 1$ be the compound growth rate.

RESULTS AND DISCUSSION

Current trend of sugarcane area, production, yield and gur production

The area under sugarcane cultivation has been decreasing over the last decades. There were considerable temporal fluctuations in both acreage and production of sugarcane which resulted in sugar production in Bangladesh. During 1990-91 to 2006-07 average total area under sugarcane cultivation was 88.71 thousand hectares where as production was 4164 thousand tons. For the same period average yield of sugarcane was 46.89 t ha^{-1} and sugar production was 166 thousand tons. At present, total cultivated area in Bangladesh is 8.29 million hectares of which only 1.07 per cent under sugarcane cultivation (BBS, 2006). The growth rate of sugarcane cultivation area, sugarcane production and sugar production showed negative trend which were -1.06, -1.37 and -4.43% respectively whereas yield of sugarcane, gur production and importation of sugar showed positive trend which were 0.62, 0.05 and 19.33% respectively (Table 1). The variation in sugarcane production was mainly due to the reducing of sugarcane areas which is subjected to relative profitability of competitive crops, especially short duration vegetables and pulse crops. However, damages of sugarcane due to natural calamities and non-availability of sugarcane to the sugar mills for milling was also responsible. Availability of sugarcane for milling is highly co-related with the price of sugarcane offered by the sugar mills (Alam, *et al.,* 2008).

Domestic production of sugar and gur Vs importation of sugar

The demand of sugar and gur is increasing with the increase of population in Bangladesh. Due to low recovery, supply shortage of sugarcane to mills and under capacity utilization, sugar production is not increasing and last few years importation of sugar increased tremendously to met up the required amount of sugar as Bangladesh is not self sufficient in sugar production. During 1990-91 to 2006-07 mean production of sugar was 0.17 million tons far below than installed capacity of 0.21 million tons (Table 2). The gap between demand and supply of sugar and gur in the country is still high. In 2006-2007 season internal demand of sugar considering annual per capita demand of sugar 10.0 kg stand at 1.40 million tons. Sugar production in 2006-07 was 0.11 million tons which met only 8 percent of the internal demand of sugar. Bangladesh, through BSFIC and private agencies imported 1.25 million tons of sugar about 89% of internal demand of sugar in 2006-2007 against the effective demand of 1.40 million tons of sugar.

During 1990-91 to 2006-07 mean domestic production and importation of sugar and gur were 0.99 million tons met 56% of the country's demand and deficit was 0.75 million tons (43% of the internal demand). Availability of sugar both from internal production and importation during the period 1990-91 to 2006-07 was 0.58 million tons on an average. Per capita availability of sugar and gur were 5.8 kg and 3.0 kg as against demand of 10 kg sugar and 3 kg gur respectively during the period. For the last 17 years from 1990 to 2007 there were deficit of around 0.75 million tons of sugar and gur on an average (Table 2). This huge deficit amount of sugar was met up by illegal border trade or either low per capita consumption of sugar or both. This deficit can be met up either by increasing domestic sugar production as there is scope to increase domestic sugar production upto 0.21 million tons by increasing recovery per cent, full capacity utilization and management improvement or either by importation of sugar for which require more foreign currency. So, we have to find domestic alternatives. As we have long tradition of cultivating date palm and palmyra palm which are the most important sources of gur in Bangladesh could be the best alternatives.

Profit and loss of the sugar industry

Sugar industry of Bangladesh is making huge losses every year. During 1990-91 to 2005-06 the industry made losses of Tk. 8124.25 million and profit of Tk. 740.49 million only in the crashing year 1994-95 and 2005-06 the industry made profit. However, the industry provided Tk. 26134.22 million to the national exchequer as VAT, Tax, Excise duty, Lavy etc during the said period (Table 3). The reason of making profit in the year 1994-95 and 2005-06 was higher domestic sugar price than the production cost of domestic sugar. Besides, imported sugar price was higher than domestic sugar price due to world high sugar price during these two years respectively. In 2005-06 year, sugar production cost of BSFIC was Tk. 32 per kg and sold in domestic market at Tk. 60 per kg which indicates only increased sugar price could make the industry viable. The sugar industry of Bangladesh made losses on an average Tk. 461.48 million per year during aforementioned period.

World sugar market

World sugar market is surplus and subsided. For the year 2006-07, the International Sugar Organization (ISO) has estimated a higher global sugar surplus of 7.2 million tons. The ISO had in November, 2006 estimated the surplus at around 5.8 million tons. In its quarterly report released in February 2007, the ISO said global sugar output is estimated at 160.2 million tons against a consumption demand of 153 million tons. World consumption is projected to grow by 2.15% only a fraction down from the 10- year average of 2.29% (ISO, 2006). The sugar industry of Bangladesh made profit in 2005-06 year due to higher price of sugar in the world market. The EU and USA provide huge amount of export subsidy for sugar every year which resulted low world sugar price.

Cost and Return from date palm plant

It can be shown from Table 5 that date palm gur production cost was Tk. 330.0 plant $^{-1}$ per season of which about 62, 18 and 14 per cent were for fuel, gachee and labour cost respectively. Higher standard deviation indicating variation of cost among respondents. Per plant gross return was Tk. 688.4 and gross margin was Tk. 358.4. Return per Taka investment (variable cost basis) was Tk. 2.08.

CONCLUSION AND RECOMMENDATIONS

In one hand, the demand of sugar and gur for various purposes keeping pace with population growth is increasing. On the other hand, sugarcane cultivation is now gradually being pushed to low-lying marginal lands prone to water-logging, flooding, drought and salinity stresses due to increased demand/production of cereal and vegetables crops. So, there is hardly scope to increase sugarcane acreage to meet the higher demand of sugar and gur for ever increasing population in Bangladesh. So to meet up future demand of sugar and gur we have to find alternatives.

Develop date palm plant as an alternative source of sugar/gur

A recent study by Alam *et al.*, 2008 revealed that a farmer could get 23.12 kg gur per date palm tree during juice tapping season (about three months). According to FAO recommendation per capita 13 kg sugar/gur is required for human diet. One date palm plant cultivation in homestead/

embankment/ponds/road sides/marginal lands or boundary of plots of different crops that remain fallow might meet the demand of sugar and gur of a person in Bangladesh. So, date palm cultivation in homestead, embankment, ponds, road sides, marginal lands and boundary of plots of different crops that remain fallow would be an alternative of sugar/gur in Bangladesh. This will increase production of gur and also sugar as sugarcane used for juice and gur making will be reduced and also will increase income of rural population and thus contribute to reduce poverty and uplift meant of nutritional status of mass rural peoples (Alam *et al.*, 2008). According to BBS report, date palm and palmyra palm is grown in around 10755 to 10767 hectares of land and total estimated juice production is 3.34 to 3.48 million tons and @ 10% gur recovery about 0.334 to 0.348 million tons of gur is produced per year in Bangladesh. These trees survive in severe drought, flood and water logging conditions. Besides, millions of additional trees can be grown through application of agro forestry approach in the crop fields. Steps should be taken to develop this sweeteners crop in Bangladesh with a view to meet up increasing demand of sugar and gur of growing population.

Increase yield per unit area

Per hectare yield of sugarcane in Bangladesh is low about 48 ton/hectare in mills zone compared to other countries. Higher sugar containing varieties so far evolved by BSRI could be cultivated at farm level with recommended input use. Many farmers cultivate traditional varieties in the mills zone and those cultivate high yielding sugarcane varieties; usually do not follow proper management practices, and do not use recommended input which resulted low sugar yield. All the extension agencies BSFIC, DAE, NGOs should work together to disseminate modern technologies towards sugarcane farmers.

Increase area under intercropping

As there is hardly scope to increase sugarcane land in Bangladesh so to sustain sugarcane cultivation i.e. sugar industry the only alternative is to increase yield per unit area. Per hectare yield of sugarcane in Bangladesh is low about 48 ton/hectare in mills zone compared to other countries. Higher sugar containing varieties so far evolved by BSRI could be cultivated at farm level with recommended input use. Many farmers cultivate traditional varieties in the mills zone and those cultivate high yielding sugarcane varieties; usually do not follow proper management practices, and do not use recommended input which resulted low sugar yield. All the extension agencies BSFIC, DAE, NGOs should work together to disseminate modern technologies towards sugarcane farmers.

Subsidy for sugarcane

The ongoing subsidy programme for sugarcane should be continued and extended. Government should provide subsidy on sugar production to minimize sugar production cost. The difference between domestic sugar production cost and imported sugar price should be adjusted through subsidy. BSFIC should again get responsibility to control importation of sugar and fixing price of imported sugar.

Develop different linkages of sugar industry

Sugar industry has diverse linkages opportunity that should be explored so that more attention can be given on that area to develop and make the industry more profitable. Sugar is used for many purposes as in sweet meat shop, tea stall, medicine, beverage, confectionery and for direct consumption that act in favour of forward linkages of sugar industry. By product of sugar industry (molasses, baggase, pressmad) can be used for many purposes. Sugarcane is the main raw materials of sugar industry. To develop sugarcane many scientists and institutions are involved that creates backward linkages of the industry. Sugarcane is also used for gur, juice and chewing purposes creating new scope for employment. These areas are not taken into consideration to develop. Now it is necessary for Bangladesh to develop at first the backward linkages of sugar industries that help to increase the production of sugar and reduce importation of sugar. At the same time the increased domestic production will create the opportunity of forward linkages industries viz Bakery and confectionary, beverage, pharmaceuticals products. By-product of sugar industries can also provide opportunities of distillery plant, livestock feed, paper and pulp and also generation of electricity and ethanol that will create huge employment opportunity. Now, it is important to explore the backward and forward linkages opportunity of sugar industry where by giving due importance new form of employment can be created and would viable sugar industry and thus contribute to reduce mass poverty of Bangladesh (Alam *et al.,* 2008).

However, steps should be taken to increase sugar recovery percent. For this more efforts on developing high sugar recovery varieties suitable for different agro-ecological zones of Bangladesh is a priority task. Sugar recovery can be increased through effective management, maturity based harvesting, scheduling and minimizing of time lag in between sugar industry and sugarcane crushing in the mills etc. More biological and agronomical research on date palm and palmyra palm should get priority as alternative sources of sugar and gur in Bangladesh.

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Table 1:Acreage, production and yield of sugarcane in Bangladesh (1990-91 to 2005-06)
(In Thousand)

Year	Area (ha.)	Production of Sugarcane (ton)	Yield (t ha^{-1})	Sugar Production (ton)	Gur Production	Sugar Import
1990-91	95	4696	49.19	246	432	138
1991-92	96	4491	47.03	196	482	50
1992-93	88	4247	48.28	187	415	64
1993-94	92	4576	49.61	222	334	86
1994-95	99	5030	50.81	270	285	156
1995-96	96	4341	45.25	184	371	28
1996-97	86	4098	47.33	135	463	207
1998-98	88	4191	47.56	166	415	160
1998-99	94	4124	43.71	153	359	191
1999-00	86	3526	42.82	123	427	115
2000-01	75	3362	44.90	98	436	328
2001-02	88	4476	50.71	204	306	210
2002-03	105	4595	44.59	177	322	600
2003-04	84	3948	46.52	119	450	700
2004-05	78	3516	44.99	106	450	1000
2005-06	75	3458	46.84	133	420	1200
2006-07	83	4112	47.03	109	400	1250
Average	89	4164	47	166	398	381
Growth rate	-1.06	-1.37	0.62	-4.43	0.05	19.33

Source: BSFIC Annual Reports (1990-91 to 2005-06) and BBS (2005)

Table 2: Production, demand and import of sugar and gur in Bangladesh (1990-2006).

Year	Population (million)	Per capita demand of sugar and gur @13Kg. ('000 ton)	Sugar production ('000 ton)	Sugar import ('000 ton)	Gur production ('000 ton)	Supply of sugar and gur ('000 ton)	Deficit ('000 ton)
1990-91	109.6	1425	246	138	432	816	609
1991-92	111.4	1448	195	50	482	682	766
1992-93	113.2	1472	187	64	415	666	806
1993-94	117.7	1530	221	86	334	641	889
1994-95	119.9	1559	270	156	285	711	848
1995-96	122.1	1587	184	28	371	583	1004
1996-97	124.4	1617	135	207	463	805	812
1997-98	126.7	1647	166	160	415	741	906
1998-99	129.1	1678	153	191	359	703	975
1999-00	131.5	1709	123	115	427	665	1044
2000-01	132.0	1716	98	328	436	862	854
2001-02	133.0	1729	205	210	306	721	1008
2002-03	134.0	1742	177	600	322	1099	643
2003-04	134.0	1742	119	700	450	1269	473
2004-05	140.0	1820	106	1000	450	1556	264
2005-06	140.0	1820	133	1200	420	1753	67
2006-07	140.0	1820	109	1250	400	1759	61
Mean	**-**	**-**	**176.29**	**400.41**	**421.59**	**995.65**	**751.7**

Source: BSFIC Annual Reports (1990-91 to 2005-06), Bangladesh Bank (2006) and BBS (2005).

Table 3. Profit and loss of sugar industry in Bangladesh (1990-91 to 2005-06).

(Tk. in million)

Crushing Season	Sugar Production (MT)	Recovery (%)	Sugar Production Cost (Tk/kg)	Sale Price (Tk/kg)	Profit	Loss	Revenue to the National Exchequer
1990-91	246.49	7.93	26.48	27.18	-	95.94	1293.60
1991-92	195.59	8.18	28.59	25.00	-	655.74	1306.19
1992-93	187.48	8.4	28.86	25.10	-	829.49	874.70
1993-94	221.55	8.21	27.74	26.50	-	252.51	1127.05
1994-95	270.20	7.76	26.77	27.00	78.89	-	1046.06
1995-96	183.93	7.71	30.41	27.00	-	379.28	1344.08
1996-97	135.32	7.67	33.79	27.00	-	659.19	1802.80
1997-98	166.46	7.84	31.65	27.47	-	385.73	1794.55
1998-99	152.98	6.61	36.57	27.47	-	1305.90	1771.03
1999-00	123.50	7.66	37.19	27.47	-	1117.71	1382.76
2000-01	98.36	7.18	45.09	27.47	-	1352.26	1358.25
2001-02	204.33	7.27	34.29	27.47	-	1181.19	858.70
2002-03	177.40	6.73	32.92	26.50	-	972.49	299.49
2003-04	119.15	7.26	37.65	27.00	-	594.80	349.10
2004-05	106.65	7.53	35.32	32.00	-	175.70	NA
2005-06	133.28	7.19	32.50	42.00	661.60	-	NA
Total					**740.49**	**8124.25**	**16608.36**

Source: MIS Report, BSFIC, 2006.

Table-4: Price of sugar in domestic market, world market & preferential market (1990-2007).

(Taka/Ton)

Year	Domestic Production Cost	Domestic Price	World Market Price (CIF)	Import price (CIF)+ Duties	Preferential Price
1999-00	37190	29470	14000	21908	38500
2000-01	45090	29470	14700	23003	38850
2001-02	34290	29470	14700	24482	39200
2002-03	32920	28500	15400	25858	39550
2003-04	37320	34000	21700	31792	39900
2004-05	37000	36000	24500	36382	40250
2005-06	32000	60000	33880	52175	40600
2006-07	36000	26000	21350	24000	40950

Source: BSFIC, BBS, BB, USDA & BSRI.

Table 5: Average cost of gur production in 2006-07 cropping year per date palm plant.

Particulars	**Cost (Tk $^{-1}$ plant)**	**Standard deviation**	**Percentage of total cost**
Gachee (juice tapping)	60	23	18
Fuel for gur production	205	40	62
Labour	45	23	14
Pot and others	20	15	6
Total	330.0		100
Gross return (Per Plant)	**688.4**		
Gross Margin	**358.40**		
Return per Taka investment (variable cost basis)	2.08		

Source: Adopted from Alam *et al.,* 2008

CANE YIELD AND SUGAR POTENTIAL OF SUGAR CANE PROMISING GENOTYPES UNDER THE AGRO-CLIMATIC CONDITION OF BANNU NWFP.

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ABSTRACT

The response of total 73 promising genotypes of sugarcane was studied in seventeen different trials at Agricultural Research Station, Serai Naurang (Bannu) during 2008-09 and 2009-2010**.** Variety S-98-SP-341 showed the highest significant average cane yield of 149.06 and 143.57 t ha^{-1}, followed by varieties Bannu-1, S-98-CSSG-557 and Bannu-3 showing next higher average at par average, cane yield of 138.47, 135.63 and 131.63 t ha^{-1} respectively. Varieties MS-91-CP-582, S-98-CSSG-676 responded with maximum sugar recovery of 12.36 and 12.0 % respectively. The highest sugar yield (14.7 t ha^{-1}) was recorded for S-98-CSSG-557, followed by Bannu-3 and S-98-CSSG-676 possessing at par sugar yield of 13.22 and 13.05 t ha^{-1} respectively.

Key Words: Sugar cane varieties yield, sugar potential.

INTRODUCTION

Sugarcane is a high value cash crop and plays vital role in improvement of socio economic condition of farming community, industry and trade situation. Being a major source of white sugar it generates national income through excise duty and its by products like molasses, baggas etc are utilized for several purposes. Thus it is a multi purpose cash crop and engages millions of people on various aspects. In Pakistan sugarcane meets 75% requirements of sugar production and almost the total production is insufficient for existing 82 sugar mills. Pakistan ranks 5th in cane growing countries, covering about 1.00 million hectares area annually, while sugar industry is 2nd to textile.In NWFP sugar cane is grown on about 0.04 million hectares and its production is inadequate to meet the existing sugar mills. According to Bollmann *et al* (2007) our sugar demand is the highest on national level i.e. 3.8 million tons (25kg per capita) as compared to developing countries.

The average cane yield, sugar % is lower both on Provincial and national level (47–50 t $ha^{-1}$and 8.0- 8.6 %) as compared to world average i.e. 63.7 t ha^{-1} and 10.6 %. Main cause for low cane, sugar potential is that 58 % varieties are unapproved and of inferior quality in the country. . In southern part of NWFP mostly old, susceptible varieties like Triton and Co-1148 are grown on commercial level. Although quite standard yield of 30–140 t ha^{-1} with 11.27 % of sugar recovery was recorded for varieties S-88-US-479 and Thata-10 by Bahadar *et al.,* 2007.

According to Majid M.A and A. Shahid the total cane production share is 65, 25 and 10 % for Punjab, Sindh and NWFP respectively. They reported average cane yield of 48.8 t ha^{-1} with total area as 0.907 million hectares of sugarcane on country level. Sugar cane cultivation is gradually increasing in Southern parts of NWFP due to establishment of new Sugar mills. Keeping in view the demand of farming community necessary research activities are under process at this Regional Research Station for evaluation of new quality/suitable varieties for southern parts of the Province.

MATERIALS AND METHODS:

The response of seventy-three promising genotypes was studied in seventeen different trials at Agricultural Research Station, Serai Naurang (Bannu) during 2008-09 and 2009-2010. The trials were conducted in RCB design with three replications in net plot size of 3.0 x 5.0 m with rows 75 cm a part. Recommended levels of NP @ 150-56 kg were applied to the trials at appropriate stages. Phosphatic fertilizers were applied at the time of land preparation. Weedicide Gaxapex Combi was applied @5.6 kg/ha during the month of February for the control of weeds. Insecticide Carbofuaran Granules were applied @12 kg/ha in two equal doses with 25-30 days interval in the month of May-June. Nitrogenous fertilizers were applied in two uniform doses in the above duration/interval. Necessary observations were regularly recorded on major parameters. Data on cane yield was analyzed statistically through compute package M-STATC.

RESULT AND DISCUSSION

Cane yield

The data mentioned in table.1-16 revealed significant difference in varietal means for cane yield. Variety S-98-SP-341 exhibited the highest significant average cane yield of 149.6 and 143.57 t h^{-1} (Table- 11,12) followed by varieties Bannu-1, S-98-CSSG-557 and Bannu-3, possessing the next higher and at par cane yield of 138.47, 135.63 and 131.63 t ha^{-1} respectively (Tables- 13,15,10). Similar results were reported by other scientists. Kaloi *et al.,* (2007) recorded the maximum cane yield of 146.48 t ha^{-1} for variety HoTh-326. Anonymous also reported higher cane yield of 123.49 t ha^{-1} for variety Bannu-1. Ghaffar *et al.,* (2008) obtained the average cane yield of 94.17 t ha^{-1} from variety CP-85/1491. According to Panhawar *et al.,* (2008), HoTh-318 exhibited better cane yield of 119.26 t ha^{-1}. Nadeem *et al.,* 2009 recorded average 101.77 t ha^{-1} of cane yield for S-2002-US-312. Anonymous 2009 found S-2001-US-400 with 86.3 t ha^{-1} average cane yield.

Sugar percentage

According to the data in table- 7 variety MS-91-CP-582 responded with the maximum sugar recovery (12.36 %), followed by S-98-CSSG-676 showing average 12.0 % of sugar contents (Table- 6). The results are in accordance with Anonymous, 2007 who reported MS-91-CP-223 and S-98-CSSG-676 with higher sugar recovery i.e. 12.34 and 12.0 % respectively. Bahadar *et al* 2007 also recorded better sugar contents of 11.27 % for Thatta-10. Kaloi *et al* 2007 found HoTh-348 with highest sugar contents i.e. 14.86 %. Panhwar *et al.,* 2008 reported HoTh-307 and HoTh-349 with higher sugar recovery of 12.89 and 12.85 % respectively. According to Nadeem *et al.,* 2009, S-2002-US-312 possessed higher sugar of 13.84 %.

Sugar yield.

According to table- 15 variety S-98-CSSG-557 showed the maximum sugar yield of 14.7 t ha^{-1} followed by Bannu-3 and S-96-SP-302 producing statistically at par average sugar yield of 13.22 and 13.05 t ha^{-1} respectively (Table 10,11). The results are analogous with anonymous 2007 who found NSG-555 with better sugar yield (13.38 t ha^{-1}). Accordingly Kaloi *et al.,* 2007 recorded the highest sugar yield (20.6 t ha^{-1}) for HoTh-2109. Panhwar *et al.,* 2008 also obtained higher sugar yield (15.46 t ha^{-1}) from HoTh-38. Similarly Ghaffar *et al.,* 2008 recorded average sugar yield of 10.8 t ha^{-1} for CP-85/1491. Munir *et al.,* 2009 also found better sugar yield for HSF-240 i.e. 13.61 t ha^{-1}. According to Nadeem *et al.,* 2009, S-2002-US-312 responded with comparatively higher average sugar yield of 14.8 t ha^{-1}.

Table 1. Varietal evaluation trial-Early season (Plant crop 2008-09)

S. No	Variety	Cane yield Mt ha^{-1}	Recovery %	Sugar yield Mt ha^{-1}
1	Bannu-3	8.56	10.20	8.22
2	Naurang-98	84.75	9.61	8.14
3	CP85/1491	81.95	10.00	10.48
4	MS-93-CP223	110.82	10.81	12.0
5	CPHS-35	74.11	10.42	7.72
6	MS-94-CP-90	78.69	10.52	7.87
7	S-98-CSSG-709	92.68	9.05	8.39
8	S-97-US-141	88.94	9.8	8.72
9	CP-88/1165	66.58	9.43	6.28
10	CP-89/846	96.9	9.28	9.00

Table 2. Varietal trial-Early season (2nd Ratoon crop 2008-09)

S. No	Variety	Cane yield Mt ha^{-1}	Recovery %	Sugar yield Mt ha^{-1}
1	S-96-SP-1058	65.44	11.12	7.28
2	S-88-US-479	66.61	10.94	7.28
3	MS-91-CP-586	57.13	10.483	5.98
4	S-78-US-421	49.96	11.56	5.77
5	CP-89/846	51.48	11.55	5.94
6	Bannu-3	58.03	10.67	6.19
7	CP-88/1165	72.65	11.55	8.39
8	S-87-US-1819	53.99	10.61	5.73
9	S-96-SP-571	39.36	9.57	3.76
10	S-97-US-128	45.84	8.98	4.12
11	Naurang-98	77.1	10.32	7.95
12	CP-85/1491	66.88	7.15	4.78
13	MS-91-CP-90	53.19	10.92	5.81
14	S-87-US-1327	61.87	10.48	6.48
15	CPHS-35	64.24	8.66	5.56
16	CPF-236	68.18	10.96	7.47

SUGAR INDUSTRY ABSTRACT

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EPA Challenges for bagasse fired power stations
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Co-Products: Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010 PP.141

Keywords: Cogeneration, Environmental Impact, Emissions.

Traditionally, the sugar industry has been treated leniently with respect to emissions standards but, as it focuses more on electricity as a profitable by-product, that is changing even though bagasse is a renewable fuel. Nowhere is that more the case than at US Sugar's Clewiston factory in Florida: even though it is not a major exporter of electricity, when it installed a new boiler, the factory was obliged to conform with stringent EPA standards. The challenges imposed by the standards are discussed together with the engineering solutions and the results obtained. The outline specification was for a 500 000 lbs/h [~226 800 kg/h] boiler delivering 600 psig, 750^0F [~4137kPa, ~399^0C] steam when firing bagasse.

The main challenges were seen in obtaining the 0.026 lbs/MMBTU [~24 mg/Nm^3] PM_{10} limit and the original 0.12 lbs/MMBTU [~70 ppmvd] NOx limit without exceeding the 0.38 lbs/MMBTU [~363 PPmvd] CO limit or the 20 PPmvd ammonia slip limit. Continuous monitoring was required. Engineering was supported by fluid dynamic studies, in particular with respect to the NOx and CO profiles in the furnace: i) maximum NOx reduction was required from the urea injection system so location was critical; and ii) engineering down combustion NOx increases CO. In the event, the unit comfortably passed all tests. The available OFA nozzles which had been installed proved particularly useful in tuning the boiler and the low uncontrolled NOx levels [meaning there will be reduced urea charges] were pleasing to see. While these stringent requirements are unlikely to be applied to other bagasse boilers in the short term, the lessons will make it possible to rise to those challenges when they arise.

Acidity Neutralisation Assessment and Remediation of a Constructed Wetland in Sugarcane Land
R.g. Quirk,A.S. Kinsela, I. White, B.C.T. Macdonald, T. Zwemer and M.D. Melville
Agronomy: Proceeding of Int. Soc. Sugar Cane Technolo., Vol 27, 2010

A constructed wetland of six level-terraced bays has been trialled for treating acidic sugarcane land drainage arising principally from the oxidation of acid sulfate soils. A concern has been that the cane land may have been permanently degraded for future cane production due to the accumulation of acidic metal contaminants (especially iron and aluminium) stemming from this remediation technique. The site is now being remediated so that it can be returned to cane production. Following initial measurements to establish the water quality and sediment characteristics in the wetland, assessment was made of the required acidity neutralization by liming, and these results were compared with best management practices for acid sulfate soil drains of New South Wales cane areas. Lime application and its incorporation were accompanied by removal of constructed banks and re-levelling of the cane block. The ability of the constructed wetland to neutralizing capability of constructed wetlands, as determind by changes to pH, electrical conductivity, dissolved oxygen, and metal concentrations. Total acidity of surface soils (0-50mm) was measured as being comparable with drain sediment in acid

sulfate soils. Lime application, its incorporation, and re-levelling of the wetland site are within the scope of standard farmland practices. This approximately 1.6 ha constructed wetland surface was only capable of treating ~10% of the total acidity discharge from the 100 has cane farm. The adoption of this as standard practice in acidic sugarcane drainage treatment is therefore impracticable. However, the principles shown here have potential for application in management of vegetated drains. Results show that the land used for the constructed wetland has not been permanently damaged by this trialled acidity remediation device.

Recovery of Nirtogen (^{15}N) by Sugarcane from previous crop residues and urea fertilization under a minimum tillage system

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Agronomy: Proc. Int. Soc. Sugar Cane Technolo., Vol.27, 2010.

Residues of green-harvested sugarcane contribute to nutrient recycling in production systems. Therefore, better understanding of trash decomposition dynamics can help crop fertilization management. This study was conducted during the 2006-2008 seasons in Jaboticabal, north-eastern Sao Paulo State, Brazil and aimed to evaluate the nitrogen recovery rates from the previous crop residues or from urea applied on sugarcane planting in a minimum tillage system, thus without trash and rhizome incorporation in crop renewal. Previous crop residues consisted of 9 and 3 t/ha of sugarcane trash (dry tops + leaves) and root system (roots + rhizomes) enriched with 1.07 and 0.81% ^{15}N isotope, respectively. These contributed 51 and 33 kg/ha of N. ^{15}N labeled trash laid on the soil surface and buried ^{15}N-root system attempted to simulate the original field residues disposal. The SP81-3250 variety was planted with 80 kg N/ha of a 5.17% ^{15}N-labelled urea. Recovery of sugarcane residues-N (trash – N and root system-N) or urea-N incorporated to the soil at planting were evaluated in distinct plant parts (stem, tops and dry leaves during during three consecutive harvest seasons. Recovery of urea-N was higher in the first harvest season (31% of initial N rate) and its uptake decreased in the second and third to 5% and 4%, respectively. In later harvested seasons, urea-N had probably been turned-over as soil organic matter and/or microbial biomass but remained in the soil N pool and available for plant recovery. Trash-N uptake closely resembled urea-N uptake, and only 13% of its N content was recovered in the first year, followed by 7% and 3% in the second and third seasons. Root system-N recovery was different since the second cut uptake was higher than the first followed by the third, 9%, 6% and 2% respectively. Three year cumulative recovery of urea-N, trash-N and root system-N was 39%, 23% and 17% respectively. Most recovered N was found in stems followed by tops and dry leaves.

Use of historical multi-location sugarcane variety trials data to indentify relationships among environments in terms of genotype response

D. Bissessur, C. Ramnawaz and K.Ramdoyal

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In Mauritius, sugarcane is grown over diverse environments that can be grouped into three main zones: the superhumid, Humid and Subhumid. In each zone, multi-location variety trials are established with several genotypes to provide reliable information for identifying high yielding varieties. Genotype ^{x} Environment (G x E) interaction is the major complicating element in selecting genotypes suitable for commercial production. However, one of the difficult aspects of conducting trials in several environments is the choice of test sites. It is important to plan a rational variety-testing program with confidence. Available historical data were used from four series of final phase trials established in different years to study the main effects environment

(E) and genotype (G) as well as G x E interactions. The aim was to identify relationships among test sites in terms of genotype responses and to assess the extent to which environments were similar or different. Cumulative results of a plant crop and three ratoon crops for cane yield (TCH) were analysed. In the superhumid zone, located at high elevation, G x E interaction was not important within the rocky (B) and the deep free (F) soils. In the contrast, a significant G x E interaction was observed within B and F soils for locations lying in relatively higher and lower elevations in different sectors. Similarly, among locations in the Humic Latosols (H2) soils and between H2 and L2 soils, interation was not prominent. Furthermore, the B, F and H soils were found to be the cause of different genetic responses. In the subhumid zone, a highly significant G x E interaction was found between all the low Humic Latosols (L1, L2) and the Latosolic Reddish Prairie soils (P2 and P3). The study confirmed that trials should be established in B, F, L and P soils mainly but should be replicated within the B and F soils prevailing in the different sectors of the island.

Secreening agronomically acceptable clones from families assessed under non-moisture limiting conditions in a managed moisture-limited environment for enhanced productivity and determination of possible selection traits

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Moisture stress is the primary abiotic stress occurring in almost all cane growing areas of India, causing drastic reduction in cane and sugar productivity. Under this situation, development of productive, moisture-stress tolerant cultivars assumes greater importance to sustain cane and sugar production. Hence, the study was under taken to identify families and traits of importance for genetic enhancement of sugarcane productivity under moisture-stress environment. A hybrid seedling population of 45 diverse inter-varietal crosses was studied for variability parameters and percent superior segregates for cane and sugar productivity in seedling and clonal generations under non-moisture stress and moisture stress environments, respectively. Further path analysis and mean performance were studied to identify important contributing traits for productivity under moisture stress involving 50 productive selections in clonal stage III with three standards. The polycrosses involving Co 8013, CoV 92101, C 81615, CoC 771, Co8371, general crosses involving Co 88025 and CoC 671 as female parents, and a cross Co 740 x CoA 7602 exhibited a better range of variability for sugar and cane productivity and produced better percent superior/transgressive segregants. The genotypic path analysis involving six biophysical traits revealed that the light use efficiency (LUE) under moisture stress and photosynthesis rate after alleviation of stress through enhanced transpiration largely contribute to cane productivity. Similarly, the path analysis of 20 other traits under moisture stress emphasized the major role of early internode formation, root length and biomass, leaf area and leaf sheath moisture at the end of the formative stage for higher cane yield. The other traits like tiller number at the mid formative stage and single cane weight (SCW i.e stalk weight) at harvest cane also be considered as selection criteria for improvement of cane productivity. Hence, for genetic enhacement of sugarcane productivity under moisture-limited environments, the familes/crosses identified could be considered as proven for isolating productive moisture stress tolerant progenies. The traits identified are effective and useful for identification of productive moisture-stress tolerant clones. Clones identified could be promoted to advanced yield trials.

Announcement:

The Sugar Processing Research Institute 2012 Conference will have as its theme: "Sugar And Bio-products: International Research Needs For the Future".

The conference will be held March 11-14, 2012, in New Orleans, Louisiana, USA, at the Chateau Bourbon Hotel in the famous "French Quarter".

Sessions will include process improvements, bio-product development, and sweetener usage. The conference will include technical presentations, commercial presentation, a sugar forum and a technical tour.

The agenda, reception and banquet along with the meeting location insure that not only will there be an informative meeting but also one where delegates can truly enjoy the venue and partnership with fellow delegates.

For further information on presenting papers and posters and to receive registration information, please contact Sugar Processing Research Institute, Inc. (SPRI), 1100 Robert E. Lee Blvd., New Orleans, Louisiana 70124,
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