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EFFECTS OF SOME NEW ORGANOCARBAMATE & ORGANOPHOSPHATE INSECTICIDES IN CONTROLLING WHITE GRUBS AND THEIR EFFECTS ON THE YIELD OF SUGARCANE IN BANGLADESH

By

M. N. A. Siddique, M. Abdullah, M. A. Alam and M. A. Rahman

Bangladesh Sugarcane Research Institute, Ishurdi, Pabna, Bangladesh

ABSTRACT

An experiment was conducted with some organocarbamate insecticides namely Myfuran 3G, Nikidan 3G, Carbotaf 5G, Rexifuran 5G, Wenfuran 5G, Agrodan 5G, Unifuran 5G, Sinodan 5G, Sinogold 6G, Wenchloro 15G, Furadan 5G to evaluate their effectiveness against white grubs and their effects on the yield of sugarcane. The experiment was carried out at Mohan farm under Thakurgaon Sugar Mills Ltd., Thakurgaon during the cropping season 2005-2006. Wenchlor 15G applied @ 2.25 kg ai ha^{-1} and rest insecticides applied @ 2.00 kg ai ha^{-1} in March and April significantly reduced the population of white grubs compared to check plots. Increased cane yield over control was recorded among the treatments ranging from 16.23 to 40.06 %.

Key words: Organocarbamate insecticides, white grubs, control, sugarcane, yield

INTRODUCTION

The soil pest like white grubs has been considered as major pest causing serious problem to sugarcane production in Bangladesh (SRTI, 1979). Different species of white grubs attack sugarcane and cause severe damage resulting loss in yield. Its attack is mainly confined to the non-flooded sandy and sandy loam soils of northern cane growing areas of Bangladesh. Seventeen species of white grubs have so far been recorded in sugarcane fields in Bangladesh causing damage every year (SRTI, 1981; SRTI 1984). But all of them are not equally important in respect of damage. Among these, *Brahmina* sp., *Holotrichia* sp., *Anomala* sp. and *Adoretus versutus* are most damaging. Heavy infestation may cause 50-60% damages, even total loss of canes. The grub's feed on the roots and under ground portion of stalks rendering the plants looking pale and sickly, ultimately the affected shoot/cane dries up which can easily be pulled out. The canes from affected clumps become unfit for crushing and as seed materials. The yield loss due to white grubs was found to be 23.07 to 38.17 t ha^{-1} (Miah *et al*., 1983).

The period of attack by white grubs is in the months of March to September but severe in March to April targeting sugarcane roots in the soil. Miah *et al*., (1986) reported that among different chemicals Furadan (Carbofuran) and Ekalux (Quinalfos) at 2.00 kg ai ha^{-1} effectively controlled white grubs. Mostafa *et al.*, (1986) reported carbofuran (2, 3-dihydro-2, 2-dimethyl benzofuran-7yl methylcarbamate) is a broad-spectrum systemic insecticide. The carbamate insecticides have both properties of killing insects by contact as well as systemic actions. The short life of carbofuran in soil is supported by Chowdhury *et al*., (2002) who reported that carbofuran after 30 days of application left no residues in soil indicating complete degradation of the pesticides. Therefore, the present study was taken to evaluate the effects of some new organocarbamate insecticides in controlling white grubs & their effects on the yield of sugarcane.

MATERIALS AND METHODS

The experiment was set up at Mohan farm under Thakurgaon Sugar Mills Ltd., Thakurgaon, Bangladesh during the cropping season 2005-2006. The experiment was laid out in Randomized

Complete Block Design (RCBD) with three replications. There were 12 treatments including one control. The treatment Furadan 5G (March + April) was considered as standard. The plot size was 6m x 6m. Block to block distance was 2m and plot to plot distance was 1m.The variety Isd 35 was used as planting material and planting was done through conventional sett placement (end to end) in the trenches on December 12, 2005. All the test insecticides were granular in formulation and used @ 2.00kg ai ha^{-1}, except Wenchloro 15G @ 2.25 kg ai ha^{-1}. The application of insecticides was done twice, one in March & the other in April. Before irrigation, soil ridges surrounding individual plots were made to protect the flow of water from one plot to another. The fertilizer application, weeding, mulching and earthing up were done as normal cultural practices. For application of insecticides furrows were made on both sides of cane rows and then insecticides (granular) were applied at the base of the plants and in the space between furrows and mixed with soils followed by irrigation. Data were taken from 5 randomly selected clumps per plot. An area of 60 cm x 60 cm was dug up from a depth of 40 cm with spade. Larval population was counted in roots and in soils of these pits. Data were taken twice, one in April and the other in June 2006. The yield of canes per plot was recorded at harvest in February 2007.

RESULTS AND DISCUSSION

From the table 1 it was observed that all the test insecticides significantly reduced white grub population over control. Data collected in April showed that white grub population ranged from 4.67 to 7.33 among the plots treated with insecticides whereas control plot had a population of 37.33 per 5 clumps. Efficacy reached 80% over control. After two applications of insecticides (March and April), data collected in June showed that white grub population varied from 1.33 to 2.67 among the insecticide treated plots whereas in control plot the population was 13.00 per 5 clumps. No Significant difference was observed among the test insecticides in respect of white grub population but all test insecticides significantly differed from control. Most insecticides treated plots showed above 80% efficacy over control, which ranged from 80.03 to 96.34% except Nikidan 3G, Carbotaf 5G, Wenfuran 5G, Agrodan 5G, Sinogold 6G, which showed 79.46% efficacy. Miah *et al.*, (1986) reported the effects of different chemicals on white grubs, among those chemicals Furadan (Carbofuran) and Ekalux (Quinalfos) both at 2.0 kg ai ha^{-1} significantly controlled the pests of which only Furadan was recommended for white grubs because it showed 190.89% yield increase over control while Ekalux showed 74.83%. Biswas *et al.*, (1994) also suggested application of Furadan 5G and Curator 5G (commonly carbofuran) against white grub @ 2.0 kg ai ha^{-1}. All these reported results support the results of present findings.

It revealed that all test insecticides showed significantly higher cane yield over control (Table-2). The yield increase over control in different treatments varied. The yield of sugarcane ranged from 48.71 to 58.70 t ha^{-1} among insecticide treated plots whereas the control plots (untreated) had yield of 41.91 t ha^{-1} only, which differed significantly over all other test insecticides. Insecticide treated plots received increased cane yield over control plots, which ranged from 16.23 to 40.06 %. Carbotaf 5G had the highest yield of 58.87 t ha^{-1} showing 40.06% increased yield followed by Rexifuran 5G which gave 57.87 t ha^{-1} showing 38.08% increased yield over control and both insecticides (Carbotaf 5G and Rexifuran 5G) significantly differ from all other insecticides in respect of cane yield. Unifuran 5G had the lowest yield among insecticide treated plots, which gave 48.71 t ha^{-1}. The result of the present findings has similarity with that of Miah *et al.*, (1986) who reported 190.89% yield increase due to effective control of white grubs with Furadan 3G (Carbafuran). Yield increase in Furadan (Carbafuran) treatments might be due to profuse root development through increased mitotic index that enhanced nutrient uptake resulting increased cane yield (Miah and Akhter, 1985). The effectiveness of any insecticide showing mortality of pests or reduction of pest infestation should reach 80% or above as the Pesticide Technical Advisory Committee (PTAC, 1980), a government body required such level of control to approve the use of an insecticide in agriculture. From the study it might be concluded that application of Myfuran 3G,

Nikidan 3G, Carbotaf 5G, Rexifuran 5G,Wenfuran 5G, Agrodan 5G, Unifuran 5G, Sinodan 5G, Sinogold 6G, Furadan 5G@ 2.0 kg ai ha^{-1} and Wenchloro 15G @ 2.25 kg ai ha^{-1} in March and April might be recommended for the control of white grubs.

Table-1 Effectiveness of different organocarbamate insecticides in controlling white grubs at Mohan Farm, Thakurgaon Sugar Mills Ltd, Thakurgaon, 2006

Treatments	White grub population (5 clumps $plot^{-1}$)			
	April data	% Efficacy over control	June data	% Efficacy over control
Myfuran 3G @ 2.0 kg ai. ha^{-1} (March + April)	5.00b	86.61	1.67b	87.15
Nikidan 3G @ 2.0 kg ai. ha^{-1} (March + April)	7.00b	81.25	2.67b	79.46
Carbotaf 5G @ 2.0 kg ai. ha^{-1} (March + April)	5.33b	85.72	2.67b	79.46
Rexifuran 5G @ 2.0 kg ai. ha^{-1} (March + April)	7.33b	80.36	2.00b	84.62
Wenfuran 5G @ 2.0 kg ai. ha^{-1} (March + April)	7.33b	80.36	2.67b	79.46
Agrodan 5G @ 2.0 kg ai. ha^{-1} (March + April)	6.67b	82.13	2.67b	79.46
Unifuran 5G @ 2.0 kg ai. ha^{-1} (March + April)	6.00b	83.93	2.33b	82.08
Sinodan 5G @ 2.0 kg ai. ha^{-1} (March + April)	4.67b	87.49	2.33b	82.08
Sinogold 6G@ 2.0 kg ai. ha^{-1} (March + April)	6.67b	82.13	2.67b	79.46
Wenchloro 15G @ 2.25 kg ai. ha^{-1} (March + April)	7.00b	81.25	1.33b	89.77
Furadan 5G @ 2.0 kg ai. ha^{-1} (March + April)	5.00b	86.61	2.00b	84.62
Control	37.33a	-	13.00a	-
LSD (5%)	3.725		1.422	

*Figures followed by the same letter (s) are not significantly different at 5% level as per LSD test.

Table-2 Effectiveness of different organocarbamate insecticides on the yield of sugarcane at Mohan Farm, Thakurgaon Sugar Mills Ltd, Thakurgaon, 2006

Treatments	Yield (t ha^{-1})	% Efficacy over control
Myfuran 3G @ 2.0 kg ai. ha^{-1} (March + April)	52.96abcd	26.37
Nikidan 3G @ 2.0 kg ai. ha^{-1} (March + April)	53.61abcd	27.92
Carbotaf 5G @ 2.0 kg ai. ha^{-1} (March + April)	58.70a	40.06
Rexifuran 5G @ 2.0 kg ai. ha^{-1} (March + April)	57.87ab	38.08
Wenfuran 5G @ 2.0 kg ai. ha^{-1} (March + April)	56.39abc	34.55
Agrodan 5G @ 2.0 kg ai. ha^{-1} (March + April)	49.82cd	18.87
Unifuran 5G @ 2.0 kg ai. ha^{-1} (March + April)	48.71de	16.23
Sinodan 5G @ 2.0 kg ai. ha^{-1} (March + April)	52.22abcd	24.60
Sinogold 6G@ 2.0 kg ai. ha^{-1} (March + April)	56.93ab	35.84
Wenchloro 15G @ 2.25 kg ai. ha^{-1} (March + April)	51.39bcd	22.62
Furadan 5G @ 2.0 kg ai. ha^{-1} (March + April)	51.39bcd	22.62
Control	41.91e	-
LSD (5%)	6.98	

*Figures followed by the same letter (s) are not significantly different at 5% level as per LSD test.

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COMPARATIVE EFFICIENCY OF SOLID AND LIQUID FERTILIZERS IN SUGARCANE

By

M. Aleem Sarwar*, Faqir Hussain*, M. Umer**, M. Bilal**, Ashfaq Nadeem*,
Arshad Ali Chattha*

* Sugarcane Research Institute, Ayub Agri. Res. Inst., Faisalabad, Pakistan

** Ph.D. Scholar, University of Agriculture, Faisalabad, Pakistan.

ABSTRACT

The respected field study comprising of five treatments of different solid and newly introduced liquid fertilizers was carried out at Sugarcane Research Institute, Faisalabad during two successive growing seasons of 2004-2005 and 2005-06. Experiment was planned to explore the effect of both fertilizer forms (solid and liquid) on the qualitative and quantitative characteristics of spring planted sugarcane variety SPF-245 that was used in the reported investigation. The results obtained showed that germination, CCS and sugar recovery, were not significantly effected while tillers per plant, number of millable canes, cane yield, and sugar yield were significantly effected by various fertilizer combinations in different treatments. Higher number of millable canes (110.20), cane yield (72.93 t/ha) and sugar yield (9.14 t/ha) were observed in that treatment where solid fertilizers in vogue were applied while other treatments, except control, produced lower results with respect to these parameters.

Keywords: Sugarcane, fertigation, fertilization, number of millable canes, cane yield.

INTRODUCTION

Sugarcane is considered a heavily soil nutrient exhaustive crop than other cash crops because of its higher dry matter production per unit area. Being a long duration crop, it depletes the fertility of soil to the maximum. Thus it should be grown on soils with balanced nutrients supply for obtaining good cane yield as 125 t/ha of sugarcane remove 84-100 kg of nitrogen, 56-67 kg of phosphorus and 168 kg of potash from soil (Barnes, 1970).

As per hectare yield of sugarcane has been increased in sugar producing countries during last few years, the use o balanced fertilizers particularly macro nutrients and generally micro nutrients have become increasing important. The forms of nutrients in soil solution as well as in solid state on soil colloids can not be considered a permanent source of profitable agriculture as depletion occurs through continuous cropping. So a balance between soil nutrients depletion and their restoration is utmost to prevent soil degradation and improve its fertility status. This emphasizes the need or supplementing the soils' supply of nutrients in order to have profitable yields. An adequate fertilizer application schedule for sugarcane production will prevent the drain of foreign exchange earnings involved at present on the import of sugar. This situation demands an increase in sugarcane yield by improving soil fertility status through different fertilizers in its various forms.

Keeping in view the role of fertilizers and importance of soil fertility in sugarcane, a number of persons conducted their research work, which is briefly discussed in the following lines. Bokhtiar *et al.,* (2001) found that 85 tones of cane crop absorbs 122 kg N, 24 kg P_2O_5, 142 kg K_2O and 48 kg S per hectare from soil. Sugumannan and Denil (1976) concluded that nitrogen application increased the total cane weight as well as sugar yield per acre. Khan and Sindhu (1967) found that yield from an application of 100 lbs. N/acre gave 11% and 48% more cane than 50 lbs. N/acre than where no fertilizer was applied. Panhwar *et al.,* (2003) determined the effects of soil and foliar application of zinc sulphate in combination with half and full recommended NPK rates on the growth, yield and quality of sugarcane. They recorded that foliar application of zinc sulphate had more beneficial

effects than soil application. Kudachikar *et al.,* (1992) applied all combinations of foliar sprays 2% $FeSO_4$, 2% $ZnSO_4$, 2% $ZnSO_4$ and 1% $MnSO_4$ at 30, 45 and 60 days after sowing. They observed that application of $FeSO_4$ and $MnSO_4$ significantly improved juice quality. Similarly, Palanivel (1990) applied 5 tonnes FYM/ha alone or with either soil applied 0, 100 or 200 kg Fe SO_4/ha or foliar application of 1.5% $FeSO_4$ at fifteen days or monthly intervals alone or in combination with 1% urea and 1% $ZnSO_4$ and reported 3.9, 6.9, 7.9, 11.5, 9.8 and 13.0 t/ha higher cane yield, respectively than control.

Considering the importance of liquid fertilizers along with solid fertilizers, the described field study was conducted to determine efficiency and feasibility of ideas, which are neither novel nor orthodox about these fertilizers in sugarcane.

MATERIALS AND METHODS

The proposed study, "Comparative efficiency of solid and liquid fertilizers in sugarcane" was conducted at Sugarcane Research Institute, AARI, Faisalabad during the two consecutive crop seasons 2004-06. A spring planted recommended sugarcane variety SPF-245 was sown in the second fortnight of March every year in deep trenches and harvested in the same week of same month in the next year. The experimental site was laid out in randomized complete block design statistically in which each treatment was replicated thrice while sowing was done @ 70,000 DBS/ha in a net plot size of $125m^2$. The soil of experimental field was loam with soil reaction (7.8), salinity ($0.51dsm^{-1}$), organic matter (0.78%), nitrogen (0.04%), phosphorus (6.20 ppm), potash (75 ppm), sand (40%), silt (35%), clay (25%) and saturation percentage (38).

All the recommended cultural and agronomic operations including weed control, inter culture, earthing up and plant protection measures were followed simultaneously during the course of study except fertilization. The fertilizers were applied according to treatments which were T_1 (0-0-0 NPK kg/ha as control), T_2 (168-112-112 NPK Kg/ha as standard), T_3 (all the liquid + solid fertilizers including nitro-20 + nutricalcium + phosphoric acid + NPK-C, 3 sprays @ 2 L/spray/100 L water at 10 days interval. After tillering completion total 6L/300L water), T_4 (168 Kg N/ha + 257 L/ha phosphoric acid + 112Kg K_2O/ha) and T_5 (nitro-20+nutricalcium +3 sprays of NPK-C+112 Kg P_2O_5/ha +112 Kg K_2O/ha).

The data regarding quantitative traits as germination, tillering, number of millable canes, cane yield and sugar yield were recorded before and after harvest respectively. While commercial cane sugar of composite cane samples from each replication were recorded in laboratory as mentioned by Anonymous (1970). Then the collected data were analysed statistically by using the analysis of variance method and LSD at 5% and 1% probability levels was applied to compare differences among treatment means as suggested by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The results regarding the studied parameters along with their statistical interpretations embodied in Table-1 and are discussed briefly under following headings.

Germination

It is considered most critical physiological phase as without it there is no plant. The data given in Table-1 indicated that the differences among various treatments for setts germination were non-significant. However, the highest (56.71%) and lowest (52.42%) germination was recorded in first and fifth treatments respectively. The non-significant effect of fertilizers on germination was also studied by Chattha (2002). These facts indicate inherent germination potential of cane setts.

Tillers per plant

Tillering potential of cane determines the ultimate crop stand and it makes up deficiencies in germination as indicated by the data presented in Table-1. The relatively poor germination was compensated by high tillering but better germination reduced tillering. A perusal of data indicated maximum number tillers per plant in the treatment where solid fertilizers were used and it was followed by third treatment where mostly liquid fertilizers were applied. But the plants of first treatment produced minimum tillers that received no fertilizer. The results coincide with Majeedano *et al.,* (2003) who claimed significant differences for tillering among fertilizer treatments in their study.

Number of millable canes

It is the interaction of germination, tillering and resistance against insect pests and disease attack. The data embodied in Table-1 indicated statistically significant differences for number of millable canes. The maximum number of canes (110.20) was observed in second treatment, which was followed, in descending order by third treatment where all newly introduced liquid and solid fertilizers were applied. The second treatment was statistically at par with third treatment while third treatment was at par with fourth. Similar results were reported by Kee *et al.,* (1999).

Cane yield

It is the most desirable character from farmer's point of view. Cane yield is the product of genetic potential of a variety and environmental conditions through agronomic management. The yield data revealed that the differences among the treatments under test were significant. The highest value of cane yield (72.93 t/ha) was noticed in second treatment, which is followed by third treatment in descending order. The second and third treatments, that received complete solid and mostly liquid fertilizers respectively, were statistically at par. Similarly the treatment receiving no fertilizer produced lowest yield which was followed by fifth and fourth treatments in ascending order. A similar experiment with this trend was conducted by Ali *et al.,* (1997).

Sugar yield

It is the function of stripped cane yield and corresponding commercial cane sugar percentage. A glance at the data given in Table-1 revealed that maximum sugar yield (9.14 t/ha) was noted in second treatment and minimum (6.42 t/ha) in first treatment while remaining three treatments produced results between these limits. Similar results were reported by Ali *et al.,* (1997).

CCS%

The real cane quality is reflected by its CCS%. It stands the factor of prime importance both from miller's and breeder's point of view as it is clear from the results reported in this paper. The data regarding CCS% as influenced by different cane varieties are given in Table-1. Statistically non-significant CCS% was recorded. The lowest CCS (12.08) was observed in fifth treatment. Similarly highest value (12.58) was recorded in control where no fertilizer was applied.

Sugar recovery

High recovery at a given stage determines cane maturity. The data pertaining to sugar recovery presents same trend as in case of CCS. The standard fertilizer treatment gave the highest sugar recovery after control while the treatment where complete package of liquid and solid fertilizers was applied followed it in descending order. This explanation is in harmony with those reported by Abd-El-Gawad *et al.,* (1992).

Table-1 Quantitative and qualitative effects of different fertilizers

Treatments	Germination (%)	Tillers plant^{-1}	Millable canes (000/ha)	Cane yield (t/ha)	Sugar yield (t/ha)	CCS%	Sugar Rec. %
T_1	56.71	1.34 c	92.63 d	51.01 d	6.42 e	12.58	11.83
T_2	53.71	1.58 a	110.20 a	72.93 a	9.14 a	12.52	11.77
T_3	55.08	1.55 ab	107.90 ab	70.14 a	8.65 b	12.34	11.60
T_4	55.32	1.52 ab	104.90 b	64.18 b	7.81 c	12.18	11.45
T_5	52.42	1.46 b	99.60 c	57.49 c	6.95 d	12.08	11.35
LSD at 5%	N.S.	0.09481	3.169	3.122	0.4041	N.S	N.S
LSD at 1%	N.S.	0.1306	4.367	4.301	0.5567	N.S	N.S

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QUALITATIVE AND QUANTATIVE PARAMETERS OF SUGARCANE CROP UNDER DIFFERENT SOURCES OF FERTILIZERS

By

*Fateh Chand Oad, Umed Ali Buriro, **M. Usman Usmanikhail and ***Muzzamil H. Siddiqui

*Sindh Agriculture University, Tandojam, Pakistan.

**Sugarcane section, Agriculture Research Institute, Tandojam.

***University college of Agriculture, Rawalakot, Azad Jamu Kashmir

ABSTRACT

The field study was conducted to evaluate the effect of different fertilizer sources on the growth, cane yield and quality parameters of sugarcane at Sugarcane Section, Agriculture Research Institute, Tandojam during the year 2003-2004. The treatments included four different sources of crop fertilization i.e. T1= NPK @ 225-112-168 kg ha^{-1}, T2= EM prepared material, T3=FYM @ 25 t ha^{-1} and T4=Press mud @ 25 t ha^{-1}. The results revealed that chemical source of fertilizer (NPK) at the rate of 225-112-168 kg ha^{-1} proved to be more effective to produce significantly. The sugarcane crop when fertilized with 225-112-168 NPK kg ha^{-1}, it produced better germination (62.15%), more cane length (211.3 cm), better cane girth (2.61 cm), satisfactory tiller production (6.50 per stool), maximum cane yield (89.35 t ha^{-1}), brix (20.41%) and sugar recovery (10.38%). EM prepared material ranked second and produced germination 58.06%, cane length 181.3 cm, cane girth 2.34 cm, number of tillers 5.56 per stool, cane yield 74.53 t ha^{-1}, brix 20.31% and sugar recovery 10.31%. The crop when fertilized with FYM @ 25 t ha^{-1}, it produced germination 56.88%, cane length 158.8 cm, cane girth 2.21 cm, number of tillers 5.38 per stool, cane yield 68.96 t ha^{-1}, brix 20.51% and sugar recovery 10.20%. The sugarcane when received fertilizer in the form of Press mud @ 25 t ha^{-1}, it produced germination 56.06%, cane length 157.5 cm, cane girth 2.19 cm, number of tillers 5.19 per stool, cane yield 64.96 t ha^{-1}, brix 20.14 percent and sugar recovery 10.15%. It was observed that NPK source of fertilizers was more effective for almost all the quantitative and qualitative characters studied as compared to EM prepared material, FYM and Press mud.

Key Words: Sugarcane, fertilizers, sources, germination, girth, tillers, sugar recovery, brix, yield.

INTRODUCTION

Sugarcane is one of the major cash crops of Pakistan and plays a vital role in providing raw material to 2nd largest (sugar) industry after textile in Pakistan. The national average remained about 47 tonnes per hectare during 2002-2003, which is far below to the world average of 63.70 tonnes per hectare. Pakistan is considerably behind (8.33%) the world average for sugar recovery (10.6%). In the Punjab province of Pakistan, sugarcane was cultivated over an area of 735.3 thousand hectares, producing 33168.6 thousand tones of cane with an average cane yield of 45 tonnes per hectare. In Sindh province, sugarcane during 2002-2003 was cultivated on an area of 258.6 thousand hectares with a total production of 13797.6 thousand tonnes averaging 53 tonnes per hectare. Likewise, in NWFP sugarcane was cultivated over an area of 104.9 thousand hectares, producing 5049.0 thousand tones with average yield of 48 tonnes per hectare. There is no infrastructure for commercial sugarcane processing in Balochistan province because sugarcane is not cultivated there on commercial scale due to unfavorable climate (GOP, 2004).

The situation in Sindh province was significantly remarkable by highest yield per hectare (62 tonnes) in the year 1999-2000. Due to shortage of irrigation water, yield per hectare declined to the tune of 50 tonnes in the year 2000-2001 and 47 tonnes in the year 2001-2002. In the year 2002-2003, the situation has been improved relatively and yield per hectare was increased to 53 tonnes

per hectare (GOP, 2004). The situation demands a comprehensive study to reorganize the planning elements that remained ineffective and resulted decline in yield per hectare due to various factors including shortage of irrigation water or low precipitation. The cane yield and sugar recovery obtained in our country is still less than the other developed cane growing countries of the world. This is mainly caused due to the fact that our farmer does not have bigger options regarding high yielding and high sucrose varieties as well as vitality of the use of chemical fertilizers for producing high yielding and recovery in sugarcane. Generally, our soils are deficient in essentially required nutrient elements and soil deficiency is removed by different means. There are several organic and inorganic sources of soil fertility improvement like green manuring, use of farm yard manure, use of presssmud, effective microorganism technology (E.M. Technology) Although, the application of chemical fertilizers is of vital importance, but use of organic fertilizers is also getting popularity and are being used as a source for improving soil fertility and getting higher yields of sugarcane. Keeping in view the importance of fertilizers in sugarcane production, a comparative study was carried out to investigate the effect of different sources of fertilizers (organic and inorganic) on the growth, cane yield and sugar recovery of commercial sugarcane.

MATERIALS AND METHODS

The experiment was conducted at the experimental fields of Sugarcane Section, Agriculture Research Institute, Tandojam during the year 2003-2004. The experiment was laid out in a four replicated randomized complete block design having treatments as: T1=225-112-168 kg NPK ha^{-1}, T2=E.M. prepared material, T3= F.Y.M. 25 tons ha^{-1} and T4=Press mud 25 tons ha^{-1}.

Land Preparation: Fully pulverized seedbed was prepared. The experimental land was prepared well before sowing on off-season. After deep plowing, crosswise goble plough, followed by precise leveling and crosswise ploughing with cultivator were given. Deep plowing was done particularly to break the hard pan of the experimental soil.

Sowing: The planting of setts was done by dry method with the overlapping arrangement. After the proper land preparation, the ridges/ furrows were prepared at the distance of 100 cm. The setts were placed in the furrows at 6-8 inches depth of furrow. After covering, the field was irrigated. Forty thousand two-budded setts per acre with end-to-end arrangement were planted in single row system.

Seed selection and treatment: The cane seed was obtained from the crop, which was not more than eight months in age (nursery seed used); upper 2/3 portion of stalk of the cane of fresh/plant sugarcane crop was used for seed purpose. Seed sets were treated with Vitavax @ 120 g/100 litre water against the attack of seed borne sugarcane diseases.

Irrigation: Overall 23 irrigations were applied.

Weeding: Weeds were removed from young crop, until the crop became in such height to shed the weeds. The weeds were controlled with the use of Gezapex Combi at the rate of 1 to 1½ kg per acre within a period of 3 months after planting. Weedicide was applied in moist conditions to get good results. First light earthing was done after 3-1/2 months of planting and second after 1½ month of first earthing.

Harvesting: The harvesting of sugarcane crop was done when the $1/3^{rd}$ leaves of the basal portion of the cane became dry and show the tendency of dropping on the ground. Scientifically, the crop becomes mature when the brix is above 20% irrespective of any variety. The quantitative parameters of the experimental crop were measured at the field, while for the qualitative parameters the cane samples from field were brought to the laboratory.

Finally the data so collected were analyzed statistically using analysis of variance, and LSD test was applied to discriminate the superiority of the means of different treatments as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Germination

The results were statistically significant ($P<0.01$) due to fertilizer sources. Germination percentage indicates the establishment of proper plant population maintained for getting a standard crop harvest. If the seed germination percentage is not upto required level, even better tillering and other yield contributing characters could not bridge the gap. The germination percentage was higher under NPK treated plots which had main association with the balanced quantities and ratios of all essentially required nutrient elements for making a seedbed optimally fertile. The results of the present investigation have also been supported by Leyva and Pohlan (1995) and Pande *et al.*, (1995) who were of the opinion that due to quite balanced ratios of NPK, chemical fertilizers yet give superior results as compared to the fertilizers of organic nature.

Cane length (m)

The differences in cane length were statistically highly significant under different fertilizer sources. Length of cane has always found affecting the yield per unit area linearly and considered as yield influencing parameter in sugarcane crop. Similar results have also been reported by Shukla *et al.*, (1995) who found N fertilizer more balanced than FYM, while Kumar *et al.,* (1996) recorded greater cane length under chemical sources of fertilizers in sugarcane.

Cane girth (cm)

The results were statistically highly significant cane girth was maximum under NPK fertilizer source. Cane girth is a genetic parameter and has straight effect on cane yield of a variety and keeps vital importance when morphology is considered. This higher cane girth under NPK treated sugarcane was due to good crop stand, which produced more cane length and obviously positive effects on cane girth. The present results are in agreement to those of Kumar *et al.,* (1996) reported that increased cane girth (diameter) was recorded from NPK treatments as compared to organic fertilizers i.e. FYM and Press mud.

Number of tillers per stool

The results for number of tillers per stool were also statistically highly significant and NPK source of fertilizer showed its superiority by producing greater number of tillers per stool over other sources. Number of tillers is a character of prime importance and increase or decrease in the tillers per stool depends upon genetics of variety or level of soil fertility. This higher number of tillers per stool under inorganic source of fertilizer (NPK) might have associated with improved soil fertility and that might be in more adequate amounts under NPK source as compared to other fertilizer sources. These results are partially supported by Uddin *et al.,* (1996) who have reported better performance of NPK fertilizers as compared to green manuring or any other organic source of fertilization.

Cane yield

The results for yield per hectare under different fertilizer sources were statistically highly significant. Yield per unit area has always been character of ultimate importance and any achievement in crop growth could not be considered until the yield per unit area is not upto the desired criteria level. The higher cane yield per hectare under NPK source was mainly associated with cane length, cane girth, number of tillers per stool and 10 canes weight. Yadav *et al.,* (1996),

Uddin *et al.,* (1996) and Lara *et al.,* (1996) reported that the cane yield per hectare was significantly greater when NPK fertilizers were applied as compared to other organic sources.

Brix (%)

The results for brix percentage under different fertilizer sources were statistically highly significant. Brix percentage in the cane juice represents the total solids available in the liquid, which contains further sugars, glucose and other solid materials. It was observed that the results for brix percentage were quite changed as was in the case of other crop growth and cane yield contributing characters. These results are confirmation Dey *et al.,* (1996), who reported that more brix percentage was obtained under inorganic sources as compared to organic sources of fertilizers.

Sugar recovery (%)

The results for sugar recovery were statistically non-significant (P>0.05) under different fertilizer sources. In quality characters, sugar recovery possesses prime importance as possessed by cane yield in the quantity characters. It was observed that the results for sugar recovery were little different to those obtained for brix percentage. These results are further by those of Kumar *et al.,* (1996), who also have reported non-significant variation in sugar content in organic and inorganic fertilizer sources.

CONCLUSIONS

It was concluded from the present study that NPK source of fertilizers was more effective for almost all the quantitative and qualitative characters studied as compared to EM prepared material, FYM and Press mud. Further studies are needed to evaluate the comparative potential of EM, FYM and press mud as sources of fertilizers in comparison with inorganic source of NPK.

Table-1 Sugarcane growth, quantitative and qualitative characters as affected by different fertilizer sources

Fertilizer Source	Germination (%)	Cane length (cm)	Cane girth (cm)	Tiller Stool^{-1}	Cane yield (t ha^{-1})	Brix (%)	Sugar Rec. (%)
225-112-168 NPK kg ha^{-1}	62.15 a	211.30 a	2.61 a	6.50 a	89.35 a	20.31	10.38
EM prepared material	58.06 b	181.30 b	2.34 b	5.56 b	74.53 b	20.31	10.31
FYM 25 tons ha^{-1}	56.88 b	158.8 c	2.21 b	5.38 b	68.96 bc	20.51	10.20
Press mud 25 tons ha^{-1}	56.06 b	157.5 c	2.19 b	5.19	64.96 c	20.14	10.15
SE	0.68	5.404	0.056	0.225	1.379	0.231	0.054
LSD(5%	2.041	16.20	0.17	0.69	4.13	-	-
LSD(1%	2.81	22.30	0.23	0.95	5.69	-	-

Values followed by similar letters do not differ significantly at 0.05 probability level.

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FACTORS AFFECTING SUGAR RECOVERY OF BANGLADESH SUGAR INDUSTRY

By

*M. Mahmudul Alam, *G. M. Monirul Alam, *M. A. Samad Miah and **S. M. Khalilur Rahman

*Bangladesh Sugarcane Research Institute, Bangladesh

**Bangladesh Agricultural Research Council, Dhaka, Bangladesh

ABSTRACT

There is a wide variation in sugar recovery per cent between research station and sugar mills of Bangladesh. The sugar mills of Bangladesh obtained around 7.57% of sugar recovery during the 1971-72 to 2005-06 crushing seasons. The industry got higher recovery of 8.40%, and the lowest 6.61% as against higher capacity utilization of 92.79% and 72.70% in the year 1992-93 and 1998-99 respectively. Growth rate analysis indicates that recovery growth was negative (-0.87) during the period where as growth rate of sugarcane cultivation area, sugarcane production, yield per hectare, sugarcane crushing and sugar production were 1.20, 2.90, 1.60, 2.70 and 2.60% respectively. Mean capacity utilization of all the sugar mills was 77.51 per cent and production was 0.16 million ton during the period and the highest sugar production was 0.27 million ton in the year 1994-95 by using capacity of 139.16 per cent. Break-even analysis showed that average 8.91% recovery was required to make the industry viable during aforementioned time. Low per hectare sugarcane and sugar yield, high processing loss, low capacity utilization, post harvest losses and inefficient management are the main causes for low recovery in Bangladesh. Environmental factors were also responsible for low recovery. Sugar recovery rate can be increased through overall proper management, efficient sugarcane cultivation management and ensuring proper technology transfer and extension services towards the farmers

Key words: Capacity utilization, gur, sugar recovery, management, efficiency.

INTRODUCTION

Sugar recovery largely depends on quality sugarcane milling and efficient factory management. High sugar content varieties of sugarcane and post harvest management are the important factors for attaining high recovery of sugar (Alam *et al.*, 2006). At present, 15 sugar mills are in operation under Bangladesh Sugar and Food Industries Corporation (BSFIC) with a capacity of 0.20 million tons of sugar production per year (BSFIC, 2004). Bangladesh Sugarcane Research Institute (BSRI) has evolved several high sugar content varieties viz.; Isd-16, Isd-20, Isd-26, Isd-31, Isd-33, Isd-35, Isd-36, Isd-37 etc. In these varieties 11-12% sugar recovery has found in the laboratory. But wide variation obtained in sugar recovery per cent between laboratory analysis and sugar mills' sugar recovery in Bangladesh. The sugar mills of Bangladesh obtained around 6.5-8.4% of sugar recovery during 1971-72 to 2005-06 crushing seasons. This is due to post harvest losses, delay in crushing, inefficient procurement policy, poor factory performance and diversion of quality sugarcane for jaggery (locally called gur) production. Besides, weather condition of Bangladesh also limiting cultivation of high sugar varieties. Prevailing environmental condition is much congenial for red rot disease infection in Bangladesh. During Pakistan period (1947-1971) recovery was 7.0-9.99% and now sugar recovery is 6.50-8.4%. This slow down of sugar recovery resulted higher production cost, low sugar production and attributes major cause of losses of sugar industry in Bangladesh. Due to the losses of the industry every year the existence of the industry is now questionable. So, proper attention should be given to increase recovery per cent in mills in order to make the industry viable. The finding of the study is expected to help all kind of stakeholders related to sugarcane and sugar industry to make the industry viable.

MATERIALS AND METHOD

All the sugar mills (15) of Bangladesh were selected for the study. Data were generally 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 (BBS). Descriptive statistics and time series data used to analyse the data of the study. For growth analysis exponential growth rate model was used. Break-even analysis was also done to calculate break-even recovery percent and production.

RESULTS AND DISCUSSION

Growth rate of recovery

Growth rate of sugar recovery, sugarcane cultivation area, sugarcane production, yield per hectare, sugarcane crushing and sugar production were estimated by using exponential growth rate model for the period of 1971-72 to 2005-06. It is observed that growth rate of sugarcane cultivation area, sugarcane production, yield per hectare, sugarcane crushing and sugar production were -0.87, 1.20, 2.90, 1.60, 2.70 and 2.60% respectively (Table-1). The study shows negative growth rate (-0.87) of sugar recovery during the period.

Factors affecting lower sugar recovery

Per hectare yield of sugarcane in Bangladesh is 48 tons only where as on an average 70 tons/ha in other sugar producing countries. Recovery per cent in Bangladesh is 6.61-8.4% while 8.5-11.0% in other countries viz.; Brazil, Australia, Thailand and Mauritius and even in some provinces of neighbouring country like India and Pakistan are also higher substantially. This low yield and recovery caused mainly for management factors in production level. Process loss is 2.25 to 4.00%, processing cost and manpower per TCD is 1.25 and capacity utilization is low about 77.51% in Bangladesh (Table 2). Time schedule of harvesting are not followed and price of sugarcane is paid on the basis of weight rather than quality. However, quality sugarcane in the mills zone usually diverted for gur production due to higher price of it in the market. Environmental factors like weather of Bangladesh and sunshine period are not favourable for cultivation of high recoverable sugar varieties as Bangladesh lies in the subtropical zone but others high sugar producing countries are located in the temperate zone. Government policies like investment, taxes and VAT, sugarcane development, sugar and sugarcane price are not helpful to the development of the sugar industries in Bangladesh.

Although BSRI evolved high recovery (11-12%) varieties but in the mills it stands at 6.51-8.4% and last few years it is almost near to 7%. Sugar recovery rate can be increased through overall proper management, efficient sugarcane cultivation management and ensuring proper technology transfer and extension services towards the farmers. In present context, minimum 9% recovery is required to make the industry profitable in Bangladesh.

Recovery and management factors

Sugar mills were under private management before liberation in 1971. The crushing seasons from 1957-58 to 1969-70 were considered to measure the efficiency between private and public management. It is observed that private management was more efficient than public management in respect of capacity utilization, sugar production and recovery rate. During 1957-58 to 1969-70, it was observed that private sugar industries mean annual production of sugar was 0.28 lake tons as against installed capacity of 0.30 lake tons and utilization capacity was 91.01% while public sugar industries mean annual production of sugar was 0.45 tons as against installed capacity of 0.74 tons and utilization capacity was 55.77%. But during private sector period 8.01% recovery was achieved while public sector period achieved 7.45% of sugar recovery. It indicates that public sector is less efficient than private sector (Table-3). So, management factor is an important aspect for attaining higher recovery.

Comparison of sugar recovery per cent between Bangladesh and Indian state

During 1988-89 to 2003-04, mean sugar recovery of Bangladesh was 7.72%, while in West Bengal and Nagaland of India it were 7.38 and 7.59% respectively, which was lower than Bangladesh. But, in Assam, Bihar and Moharastra it were 8.04, 9.07 and 11.14% respectively, which was higher than Bangladesh (Table-5). This indicates that due to the same environmental factors recovery per cent of Bangladesh sugar industries was closer to the boarder state of India West Bengal and Nagaland. But Moharastra, Bihar are far from Bangladesh and environmental conditions are different hence their recovery per cent were substantially higher than Bangladesh.

Break-even analysis

Break-even is the point at which sale price is equal to production cost and there is no loss no profit situation (Total revenue = Total cost). Break-even point of sale price, recovery and sugar production of 16 crushing season (1990-91 to 2005-06) were estimated. Table 4 shows that in most of the year sale price of sugar was less than cost of production that incurred loss to industries. Break-even for sale price represents price that makes no loss no profit situation with a given recovery and production. Similarly break-even recovery represents recovery rate that makes no loss no profit situation with given sale price and production and break-even production represents production level which makes no loss no profit situation with a given sale price and recovery rate.

It is observed that in the most crushing seasons recovery was more than 8.0%. But in the season 1999-00, 2000-01 and 2003-04 break-even recovery were 10.37, 11.79 and 10.12% respectively. This means that the sugar industry did not gain profit until the recovery rate rose to 10.37, 11.79 and 10.12% in those crushing seasons respectively. Break-even analysis showed that average 8.91% recovery was required to make the industry viable during aforementioned time.

Strategies for attaining higher sugar recovery

Increase per hectare sugar yield

In Bangladesh per hectare yield of sugarcane is low (about 48 ton/hectare in the mills zone) compared to other countries so per hectare yield will be increased. High sugar contains varieties so far evolved by Bangladesh Sugarcane Research Institute 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 take proper nursing and do not use recommended input which resulted low sugar yield. Besides, sugarcane is now gradually being pushed to low-lying marginal lands prone to waterlogging, flooding, drought and salinity stresses due to increase demand of cereals, vegetables and high value crops. However, Bangladesh is expecting to increase its sugarcane yield from 46 to 60 ton/hectare within 2010 by using BSRI package of technologies through proper demonstration and technology transfer towards farmer. Although, there are limitations of cultivating high yielding, high sugar varieties due to environmental factors hope to increase yield through proper management practices. In fact, ideal agricultural region for high sugar recovery is temperate zone but Bangladesh falls in sub-tropical zone.

Reduce processing loss

Processing loss is high in Bangladesh about 2.50-4.00 per cent. Through efficient factory management, processing loss can be reduced to 1.00-1.50 per cent like other countries. If it is possible recovery percent will be increased at expected level. Many steps have been taken to reduce processing loss that will help to increase recovery percent in future.

Minimize post harvest loss

In Bangladesh post harvest losses is also high. At times, due to lack of proper management sugarcane crushed in the mills after 48 h of harvest which usually reduces sugar recovery per cent.

Harvesting of sugarcane is done without considering maturity of sugarcane and without maintaining schedule. Price of sugarcane is given on the basis of weight rather quality. Through effective management, maturity based harvesting, scheduling and minimizing of time lag in between sugar industry and sugarcane crushing in the mills; sugar recovery can be increased.

Capacity utilization

Low sugar recovery also caused for low capacity utilization of the sugar industries in Bangladesh. For attaining high sugar recovery full capacity utilization is required. For full capacity utilization the supply of sugarcane the main raw materials of sugar industries would be ensured. Supply of sugarcane to the mills is subjected to area under sugarcane cultivation and price of sugarcane given to the farmers for sugar production in comparison to gur and juice production. As for many reasons we are not able to increase our present sugarcane land so to increase sugarcane supply to mills yield per hectare will be increased and incentive price should be paid to the farmers so that they supply sugarcane to the mills. As price of sugarcane is high in the market than government price farmers diverted quality sugarcane for juice and gur purposes that also a cause for low sugar recovery.

Table-1 Recovery growth trend of sugar industries in Bangladesh (1971-72 to 2005-06)

Crushing Season	Total Sugarcane Cultivation (ha.)	Total Production (ton)	Sugarcane Yield (Ton/ha.)	Total Sugar Production (ton)	Capacity Utilization (%)	Recovery (%)
1971-81	65932	2149361	32.07	101356	60.93	7.49
1981-91	91098	3814229	41.95	160575	86.02	8.09
1991-92	95501	4491122	47.03	195587	98.16	8.18
1992-93	87966	4246613	48.28	187483	92.79	8.40
1993-94	92250	4576394	49.61	221547	108.05	8.21
1994-95	99004	5030449	50.81	270196	136.16	7.76
1995-96	95942	4340890	45.25	183934	93.63	7.71
1996-97	86575	4097854	47.33	135320	64.30	7.67
1998-98	88130	4191153	47.56	166457	79.10	7.84
1998-99	94352	4123740	43.71	152979	72.70	6.61
1999-00	86397	3526498	40.82	123498	58.69	7.66
2000-01	74873	3361867	44.90	98355	46.74	7.18
2001-02	88274	4475990	50.71	204329	97.10	7.27
2002-03	105417	4595268	43.59	177398	84.30	6.73
2003-04	84866	3948244	46.52	119146	56.62	7.26
2004-05	78177	3516972	44.99	106645	50.68	7.53
2005-06	75426	3458042	45.84	133283	63.34	7.19
Growth Rate (%)	1.20	2.90	1.60	2.70	2.60	-0.87

Source: BSFIC Annual Reports (1971-72 to 2005-06) and BBS (2005)

Table-2 Factors affecting sugar recovery of sugar industries in Bangladesh

Factors	Bangladesh	Other Countries
A. Management Factors		
a) Per hectare yield (MT)	48.00	70.00+
b) Recovery (%)	6.61 - 8.40	8.50 - 11.00
c) Processing Loss (%)	2.25 - 4.00	1.50 - 2.00
d) Fertilization	Not follow	Recommended doze
e) Quality Cane Diversion for Gur	70% sugarcane use for gur	100% Sugarcane are used for sugar
f) Capacity Utilization	77.51%	100%+
g) Factory Performance	Inefficient	Moderate
h) Low TCD Plant	1000-1500	25000-above
B. Environmental Factors		
a) Weather	Limitation for high sugar	Suitable for high sugar variety
b) Sunshine	6 Hrs.	8-12 Hrs.
c) Precipitation	Uneven rainfall	Evenly distributed rainfall throughout

Source: BSFIC Annual Report (2004) and USDA (2004)

Table-3 Management gap between private and public industries.

Year	Installed Capacity (ton)		Production (ton)		Capacity Utilization (%)		Recovery (%)	
	Private	Public	Private	Public	Private	Public	Private	Public
1957-58	39000	15000	31917	797	81.84	5.31	9.06	5.72
1958-59	39000	40000	43908	10792	112.58	26.98	8.61	7.17
1959-60	39000	40000	39253	22307	100.64	55.77	7.87	7.84
1960-61	39000	40000	33579	20537	86.10	51.34	8.64	8.55
1961-62	39000	40000	37731	28914	96.75	72.28	8.37	8.52
1962-63	39000	60000	39968	32618	102.48	54.36	8.18	8.04
1963-64	39000	60000	43125	44605	110.58	74.34	8.04	7.77
1964-65	39000	60000	37607	36541	96.43	60.90	7.56	7.04
1965-66	17000	112000	16625	67864	97.79	60.58	8.17	7.71
1966-67	17000	112000	16510	96456	97.12	86.12	7.74	7.54
1967-68	17000	122000	15288	94701	89.93	77.62	7.67	7.62
1968-69	17000	122000	5716	52334	33.62	42.90	7.04	6.64
1969-70	17000	142000	13142	80255	77.31	56.52	7.25	6.70
Mean	30538	74230	28798	45286	91.01	55.77	8.01	7.45

Source: Australian Sugar Industry Mission Report (1976)

Table-4 Break-even analysis of sugar industries (1988-89 to 2005-06)

Year	Sugar production (ton)	Recovery (%)	Sugar production Cost (Tk./kg)	Sale price (Tk./kg)	Break-even point		
					Sale price (Tk./kg	Recovery (%)	Production (ton)
1990-91	246493	7.93	26.48	27.18	26.48	7.49	240145
1991-92	195587	8.18	28.59	25.00	28.59	9.35	223673
1992-93	187483	8.40	28.86	25.10	28.86	9.66	215568
1993-94	221547	8.21	27.74	26.50	27.74	8.59	231914
1994-95	270196	7.76	26.77	27.00	26.77	7.69	267894
1995-96	183934	7.71	30.41	27.00	30.41	8.68	207164
1996-97	135320	7.67	33.79	27.00	33.79	9.60	169350
1997-98	166457	7.84	31.65	27.47	31.65	9.03	191786
1998-99	152979	6.61	36.57	27.47	36.57	8.80	203656
1999-00	123498	7.66	37.19	27.47	37.19	10.37	167197
2000-01	98355	7.18	45.09	27.47	45.09	11.79	161443
2001-02	204329	7.27	34.29	27.47	34.29	9.07	255058
2002-03	177398	6.73	32.92	26.50	32.92	8.36	220375
2003-04	119146	7.26	37.65	27.00	37.65	10.12	166142
2004-05	106645	7.53	35.32	32.00	35.32	8.31	117709
2005-06	133283	7.19	32.50	42.00	32.50	5.56	103136

Source: BSFIC Annual Reports (1971-72 to 2005-06) and BBS (2005)

Table-5: Mean recovery per cent of sugar of Bangladesh and comparable to Indian state

Year	Bangladesh	India				
		West Bengal	Assam	Nagaland	Bihar	Moharastra
1988-1989	8.27	6.83	7.93	7.61	9.16	11.04
1989-1990	8.77	4.17	8.10	8.30	8.99	10.71
1990-1991	7.93	7.62	8.35	7.80	9.07	10.76
1991-1992	8.18	7.44	8.41	8.37	8.72	11.19
1992-1993	8.40	7.98	8.40	7.90	9.37	11.32
1993-1994	8.21	7.29	6.99	6.65	9.19	11.12
1994-1995	7.76	7.40	8.12	7.22	9.10	10.92
1995-1996	7.71	6.04	8.15	6.87	8.81	10.48
1996-1997	7.67	7.97	8.36	-	9.23	11.11
1997-1998	7.84	8.35	7.95	-	9.49	11.13
1998-1999	6.61	7.14	7.79	-	8.54	11.16
1999-2000	7.66	7.48	8.25	-	9.20	11.39
2000-2001	7.18	7.10	7.75	-	9.11	11.64
2001-2002	7.27	8.32	-	-	8.78	11.64
2002-2003	6.73	8.44	-	-	9.00	11.65
2003-2004	7.26	8.45	-	-	9.33	10.93
Mean	7.72	7.38	8.04	7.59	9.07	11.14

Source: Indian Sugar (2005)

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SUGAR INDUSTRY ABSTRACTS

By
M. Awais Qureshi and Dr. Shahid Afghan

AGRICULTURAL ENGINEERING

Performance and economics of the illovo mechanical cane cutter

P.W. L. Lyne, M.I. Langton, C. N. Bezuidenhout and J.C. Smithers
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Labour for cutting sugarcane is becoming a constraint because of a rising standard of living, labour aspirations and the fact that manual cutting is classified as hard work. In addition, manual harvesting in South Africa is often favoured because of the high cost of mechanical harvesters and steep slopes. To deal with this, a brush-cutter with a redesigned blade configuration, called the Illovo mechanical cane cutter, was developed and various performance parameters were measured in field trials. The cutter efficiency, blade durability, performance standards, ergonomics and economics were measured and analysed. These were carried out during field tests where the system was introduced to a commercial farming operation and operated in parallel with the conventional system. A work study was carried out to collect performance data, and an ergonomic study was carried out on both the mechanical and conventional system. The tests highlighted some problems and, with further development, these were dealt with and the system is now a functional cutting system. The ergonomics showed that the cutter is less demanding than the conventional system and the costs compare favourably with the conventional manual system. The system offers a viable alternative to the conventional method of manually cutting sugarcane.

Evaluating the applicability of modis data for forecasting sugarcane yields in Colombia

E. Bastidas-Obando and J. Carbonell-González
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Information on growth dynamics and crop conditions can be used to estimate crop production. Remote sensing technology can provide such information by offering temporal and spatial data during the growing season. In this paper, we evaluated the potential of using images coming from the MODerate Resolution Imaging Spectro-Radiometer (MODIS) for yield forecasting. A group of 28 images from MODIS land product MOD13Q1 were used for the growing period between January 17th 2002 and April 17th 2003. The HANTS smoothing algorithm was implemented to reduce data noise, and the effect of clouds from the Enhanced Vegetation Index (EVI) available in the MOD13Q1 product. Commercial information from 33 fields across the Valle del Rio Cauca was used to correlate yield data with cumulated EVI data for three periods during the growing season. Results showed that linear models had an accuracy of 74% for estimating crop production at the early growing stage (5th month) when fields were managed by mills. Accuracy of crop production from fields managed by farmers ranged from 37% at the early growing stage (5th month) to 68% at the late crop stage (10^{th} month). MODIS information can provide spatial and temporal information for forecasting crop production. Further yield estimation improvements should include multiple growing periods.

AGRICULTURAL AGRONOMY

Factors associated with a healthy soil in sugarcane production in Kwazulu Natal

T. Van Antwerpen, R. Van Antwerpen, J.H. Meyer, P. Naidoo, S. Berry, V.W. Spaull, K. Govender, P. Cadet, S. Rutherford and M. Laing
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Long-Term mono-cropping of sugarcane can lead to the degradation of soils and a decline in yield. In Australia, yield decline has been linked to changes in the population structure of soil micro-organisms, in particular to the build up of pathogenic fungi such as *Rhizoctonia*. While a lack of moisture is a major growth-limiting factor in many of the poorer soils under rain-fed conditions, this does not explain the overall reduction in yields and loss of sugarcane ratoons that have been reported in South Africa, even for good soils under irrigated conditions. It was therefore decided to re-examine the wide range of soil factors that could impact upon cane growth. Information from this project will be used to rate the health of soils in the South African sugarcane industry, in order to advise growers on suitable agricultural practices to maintain or improve the health of their soils and, thereby, to reverse the impact of long-term sugarcane yield decline. A field situated near Glenside in the Natal Midlands, known to be highly variable in cane yield, was identified and a 100-point grid was established across the field. The ten best and ten worst yielding grid points were identified, from which yields were determined. Soil from these high and low yielding grid points was sampled and analysed with the goal of correlating yield with soil health factors. Analyses included a range of soil physical, chemical and biological parameters. Biological factors that were positively associated with higher yielding grid points in this study included high levels of microbial respiration. High counts of the nematode, *Xiphinema elongatum,* were associated with lower yielding grid points. Aggregate stability (in the range 0.5 to 1.0 mm) was one of the physical factors that was associated with high yields. Soil chemical characteristics that were associated with high yielding plots included higher average pH values, lower Al and Na levels and higher P levels.

Ammonia volatilisation from Urease inhibitor-treated urea applied to sugarcane trash blankets

H. Cantarella, P.C.O. Trivelin, T.L.M. Contin, F.L.F. Dias, R. Rossetto, R. Marcelino, R.B. Coimbra and J.A. Quaggio
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Legal restrictions from burning sugarcane prior to harvest are causing a sharp increase in acreage which is harvested as green cane. The presence of a thick mulch of sugarcane trash after harvest makes it difficult to incorporate fertilisers into the soil. Since large losses of ammonia may occur when urea is surface applied to trash, it is important to find ways to improve urea-N use efficiency. The urease inhibitor NBPT slows down urea hydrolysis and thus may help decrease ammonia losses. Ammonia traps were set up in seven sugarcane fields covered with trash and fertilised with ammonium sulfate or ammonium nitrate, urea, and NBPT-treated urea. All N fertilisers were surface-applied at rates from 80 to 100 kg N/ha. Very little N was lost when ammonium nitrate or ammonium sulfate were used. However, volatilisation losses as ammonia from the urea treatments varied from 1.1% (rainy days after fertilisation) to 25% of the applied N. The percentage of reduction in volatilisation due to NBPT application ranged from 15% to 78% depending on the weather conditions during the days following application of N. Addition of NBPT to urea helped to control ammonia losses, but the inhibitor was less effective when rain sufficient to incorporate urea into the soil occurred 10 to 15 days or longer after fertilizer application

SUGARCANE BREEDING

Sharing the vision: a young crop improvement program addressing the challenges of a difficult production environment

N. Berding and R.O. Castillo
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The 8th Germplasm and Breeding Workshop was held at Guayaquil, Ecuador from 30 April to 5 May, 2006. The theme of the Workshop was 'Pushing the Boundaries: Innovation in Crop Improvement'. The rationale of holding the 8th Workshop in Ecuador was that we could view the operations of a relatively young crop improvement program, which had operated for about five years, addressing the challenges imposed by a difficult production environment – low incident radiation because of its geographical location, and periods of excess moisture as well as moisture stress. As well, they face the additional challenge of displacing the old Australian cultivar Ragnar that had dominated production in Ecuador for decades, and still accounts for about 70% of the production of the Ecuadorian industry. The workshop was attended by 51 people from 15 countries. Ecuador was strongly represented by a contingent of 22 people. Twenty two papers and five poster papers were presented. Two titled discussion sessions were also conducted. A field tour of the CINCAE station and trials was conducted on the Wednesday of the Workshop. An excellent social program was enjoyed by all. This included a welcoming function, an evening's entertainment of truly traditional Ecuadorian song and dance, and a Workshop dinner.

Improving sugar production—breeding fiji's future

Prema N. Naidu and Ashween N. Ram
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A new promising sugarcane (*Saccharum* spp.) cultivar, LF91-1925, was tested for milling characteristics, a prerequisite for commercial planting in Fiji. The cultivar was released for commercial production, following the test, during the 2006 planting season. The cultivar is early-maturing with higher sucrose content than the dominant existing commercial cultivars. LF91-1925 outperformed existing cultivars in cane and sucrose yields at the adaptation trials. This new cultivar was selected from the bi-parental cross *Kaba* x *Yasawa* that was made in 1991. The female parent Kaba is a popular cultivar of the industry and accounts for 6% of the total cane production. Yasawa is the male parent which is a high sugar cultivar and also a parent of two other commercials. Sugar content of LF91-1925 is 15% higher than the dominant cultivar Mana in the early part of crush. Adoption of this cultivar will ensure a continuous supply of cane with high sucrose content to mills for processing. This in turn will improve the sugar yield per unit area and profitability of the ailing Fijian sugar industry.

MOLECULAR BIOLOGY

Water deficit-related expressed sequence tags (ESTS) in the sugarcane (*Saccharum* spp.) leaf roll

M.I.T. Ferro, R.W. Noda, R.I.D. Tezza, D.F.R. Jovino, K.M. Dabbas, S.M. Zingarette & J. Suzuki
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Water stress is one of the most common environmental stresses which affect plant productivity and their geographic distribution. Plants have mechanisms for water stress adaptation that might be characterised by the accumulation of specific mRNAs as the result of specific gene activation. In this work, expressed sequence tags (ESTs) from sugarcane leaf roll submitted to water deficit stress

were analysed. Two cDNA libraries were constructed from plants subjected to 9 and 17 days of water stress. A total of 4639 sequences with good quality (minimum of 100 bases and score 20 according to the quality analysis of Phred program) were clustered using the CAP3 program. Among the clusters, 2077 ESTs were singletons and 2405 ESTs were in 905 clusters containing from 2 to 21 ESTs. Putative regulatory and metabolic proteins related to sugarcane water stress were identified from these 2982 unique transcripts (clusters + singletons) analysed by a similarity search using the NCBI BLASTX algorithm against nonredundant NCBI BLAST protein databases. Based on the NCBI TBLASTX algorithm, 188 unique transcripts were found. These unique transcripts were not similar to the unique transcripts reported by the Sugarcane EST Project from 'Genoma FAPESP' Program (SUCEST - http://sucest.lad.dcc.unicamp.br/en/), even though these results were obtained from plants grown under different environmental conditions. An analysis of the highest unique transcription frequencies data revealed a set of genes expressing metabolic enzymes such as a lipoxygenase, S-adenosylmethionine synthetase, pyrophosphate-fructose-6-phosphate 1-phosphotransferase and sucrose synthetase. All these enzymes are strictly expressed and appear to be highly related to evolution of drought stress, underlying novelties in sugarcane drought research.

Sugarcane dhurrin: biosynthetic pathway regulation and evolution
V.E. De Rosa Jr., F.T.S. Nogueira, P. Mazzafera, M.G.A. Landel and P. Arruda
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Phytoanticipins are low molecular weight metabolites that participate in plant defence against pathogens and herbivores. In *Sorghum bicolor*, the major phytoanticipin is dhurrin, a cyanogenic glycoside. Cyanide is toxic at low concentrations, because it forms a very stable complex with the active site metal (e.g., Fe and Mg) in enzymes, thereby inhibiting vital functions in cells such as respiration, carbon fixation, and nitrate reduction. Through data-mining analysis in the SUCEST database (http://sucest.lad.ic.unicamp.br/en), we identiÞed the genes encoding the dhurrin pathway enzymes in sugarcane. Phylogenetic analyses of the enzymes that participate in the pathway were generated, showing that the enzymes of the initial steps of dhurrin synthesis grouped with enzymes involved in the synthesis of oximes. However, the enzymes of the subsequent steps are only conserved in sugarcane and sorghum. Based on these data, foliar extracts from sugarcane and other species were analysed by high performance liquid chromatography (HPLC). This analysis revealed the presence of dhurrin in sugarcane at a concentration of 4.3 ± 0.8 mg per gram of leaf fresh weight, and this level did not decrease by wounding. RNA-gel blot analysis showed that the genes encoding the enzymes UDP-glucosyltransferase and dhurrinase are induced by *Diatraea saccharalis* attack and methyl jasmonate. Together, these results indicate that during evolution, the dhurrin biosynthesis pathway was conserved in sugarcane and sorghum. Also, dhurrin may act in the defence against herbivores, and its regulation possibly involves the octadecanoid pathway.

SUGARCANE PATHOLOGY

Occurrence of sugarcane diseases in the germplasm collection at mitrphol sugarcane research centre at Chaiyaphum, Thailand
Kanya Jaroenthai, Sathaporn Dongchan, Somwung Anusonpornpurm and Upsorn Pliansinchai
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Sugarcane diseases were recorded in the germplasm collection of 882 sugarcane clones at Mitr Phol Sugarcane Research Center Chaiyaphum, Thailand. White leaf and smut were frequently found in both the plant and ratoon crops with more severe symptoms in the ratoon crop. In the plant crop, 82 varieties showed 2.27%-50% of white leaf incidence and 31 varieties showed 2.33%–21.73% of smut incidence, whereas 595 and 163 varieties in ratoon cane showed white leaf and smut

incidence at 5.55%–100% and 4.54%–50%, respectively. Other diseases found were: yellow spot, ring spot, rust, red mid rib, pokkah boeng, mosaic and yellow leaf. The occurrence of each disease was recorded every month. The results indicated variation of disease incidence throughout the year that might be due to weather conditions. Disease occurrence in varieties from different sources was observed, compared and discussed.

Control of ratoon stunt (rsd) through a healthy seedcane program in Tucumán, Argentina
J. Ramallo, V. Martinez, M. Acosta and C. Funes
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Ratoon Stunt (RSD) is one of the most serious diseases in sugarcane crops in Tucumán, Argentina. In 1998, a survey of RSD conducted in commercial fields of CP 65-357 and TUC (CP) 77-42 varieties showed a decrease of 16% and 46% in production in mildly and severely infected fields. In 2004.2005, LCP 85-384 was the first variety planted in 55% of the province and it was very susceptible to RSD. During 2006, a new survey of RSD was conducted in commercial fields and serological tissue blot immunoassay technique was used for diagnosis. It showed that 82% of the samples from commercial fields showed a positive reaction for infection. LCP 85-384 and CP 65-357 showed an incidence of stalk infection greater than 60% while TUC (CP) 77-42 had less than 50%. EEAOC (Estación Experimental Agroindustrial O. Colombres) established a healthy seedcane program through micro-propagation that began in 2000 and included three categories of field nurseries planted in 2002: basic, registered and certified. RSD incidence in these nurseries was very different from commercial fields: in the basic nurseries it was zero, and in registered nurseries it was 2%. These results suggest that RSD can be controlled through a healthy seedcane program which also ensures vigorous, high yielding, and true to type cultivars.

FACTORY ENGINEERING

Cane tracking and sampling equipment: an update

F. Calboutin and S. Naidoo

With the implementation of the Direct Analysis of Cane (DAC) method of cane sampling and analysis in the South African sugar industry more than 30 years ago, it remains imperative that there is an accurate and reliable method of cane tracking and sampling. Although the basic principles of cane tracking are the same, both the application and equipment used have changed. The development of software and the availability of personal computers has revolutionised the manufacture of the cane tracking system. The advent of Programmable Logic Controllers has allowed the sample point control system to be upgraded, and the development of a new type of pulse generator has improved performance and reliability. By using video information, it is possible to transmit tracker information to any part of the factory. The reliability that has been built into the cane tracker over the years ensures that the sampling information it provides forms a solid base for the systems it supports. Future possible developments being considered are the linking of the tracker to the laboratory system, automatic tracking, and different sampling techniques.

Sintered alloy powder carbide and tungsten carbide materials for shredder hammer tips

Joydeep Duttagupta and T.R. Rama Mohan

This paper describes a new design of replaceable tip for shredder hammers that provides improved life over the conventional white iron and tungsten carbide tips. The design incorporates a two-stage

tip. The first stage is an alloy powder carbide material manufactured using an atomisation process. This material is similar in composition to the conventional white iron, but the manufacturing process results in a finer grain with a more uniform dispersion of carbides, resulting in a harder and more wear resistant surface. The second stage is a tungsten carbide and cobalt alloy with a greater cobalt content for higher toughness. The tip can be rotated 180° to provide a second impact surface, thereby doubling the life of the tip. Tests conducted at one Indian factory showed that the life of the new design of shredder hammer tip can be between 900 000 and 1 000 000 tonnes of cane.

FACTORY PROCESSING

The effect of final effect operating pressure on sucrose degradation in evaporator stations

S.D. Peacock

The choice of the operating pressure of the final effect vessel of an evaporator station has an effect on the heat transfer coefficient achieved in this vessel. This impacts on the evaporative capacity of the station. The selected final effect pressure also impacts on the rate of sucrose degradation in the evaporator station, due to its direct effect on syrup temperature and to a secondary effect on the residence time of the juice in the individual vessels. Changing the final effect pressure will change the distribution of pressures across all effects, which will affect the rate of sucrose degradation in all vessels, not only those in the final effect. In order to study these phenomena, it is therefore necessary to model heat transfer and inversion in all vessels, rather than focusing on the final effect vessels alone. By carrying out computer simulations, the effect of varying the final effect pressure on the degradation of sucrose across the station can be evaluated. Energy efficiency effects may also be investigated. Based on the results obtained, recommendations can be made on the optimal choice of operating pressure for a final effect evaporator.

Glyphosate ripener effects on the processing quality of different sugarcane tissues

G. Eggleston, R. Viator and M. Grisham

Currently, there is a dramatic shift world-wide from the harvesting of burnt to green (unburnt) sugarcane, and an associated increase in the delivery of extra trash impurities, i.e., leaves and tops, to factories putting added burdens on processors. The effect of changing to green cane harvesting on processing has not been properly or fully characterised and, therefore, few solutions to minimise the detrimental processing effects of trash have been developed or implemented. This paper reports the results of a study on the processing quality of juice from different tissues of two commercial Louisiana varieties: LCP 85-384 and HoCP 96-540. The effect of applying a chemical ripener (glyphosate), an important component of sugarcane production management, on different tissues of the plant was also investigated. Juice was extracted from lower stalk (LS), middle stalk (MS), growing point region (GPR), green leaves (GL), and brown, dried leaves (BL), 27 and 53 days after glyphosate treatment (DAT). Generally, with glyphosate treatment, there was more BL than with no treatment, and LCP 85-384 delivered more BL to the factory than HoCP 96-540, as BL adhere more tightly to its stalk. Starch was surprisingly discovered in the BL of both varieties indicating that brown, senescing leaves are still metabolically active, store starch, and are not necessarily .dead.. Starch was generally higher in all tissues of HoCP 96-540 than LCP 85-384. Overall, 53 DAT, starch decreased because of increased cane maturity, but generally less starch occurred in glyphosate-treated LCP 85-384 tissue than non-treated and vice versa for HoCP 96-540. Other differences in processing quality of the different tissues are discussed.

MANAGEMENT

Managing research: Lessons from Australia

E.S. Wallis, P.G. Allsopp and R.F. Gilmour

Research, Development and Extension plans are crucial to effective use of industry resources and need to be developed through interactions between researchers, extension officers and industry participants to ensure that the plans effectively address industry needs. This paper describes a consultative process with the Queensland sugar industry to identify their views of the products and services offered by BSES Limited and how those views were used to shape BSES' strategic plan. A three-stage process was used. In stage 1, BSES established a framework for the study. Stage 2 was a qualitative phase, involving an independent consultant working with millers and growers through one-toone interviews, or through focus groups of cohorts of 8–12 people. These discussions considered the participants' general perceptions of BSES and the value it delivers to industry, current funding of BSES, future funding solutions, and how these options could be implemented. Stage 3 was a quantitative survey of 400 Queensland cane growers conducted by consultants using a computer-assisted telephone interview process. Questions covered the awareness and value of BSES services, funding principles, support for increasing the service fee, general attitudes to change and innovation, and general demographics. The study identified five issues critical to successful R,D&E management in organisations such as BSES: collaboration; succession planning; external funding; commercialisation of R,D&E; and change management. BSES's strategic plan sees the company contributing to the goal of an internationally competitive and environmentally sustainable sugarcane production system for the reliable supply of raw sugar and diversified products from Australia. It defines seven high-priority actions that must be undertaken to achieve the goal and groups these under three delivery vehicles. The paper then describes the key lessons that the authors (with a total of over 50 years of R,D&E management) have learnt in managing the industry based R,D&E program conducted by BSES.

Miller/grower relations at the local mill group board level in south africa: an empirical investigation

A.T. Wynne and B.J. Milford

Increasing global competition, technological innovation and resource scarcity are some of the signs of worldwide change. Within the context of the South African sugar industry, potential future change events such as income diversification require innovation in sugarcane supply arrangements. Much of this change would need to be overseen by South Africa's fourteen Mill Group Boards (MGBs), bodies comprising millers and growers at each mill area. The first part of this research examined local miller / grower structures in Australia and South Africa to compare and highlight possible enhancements that can be made to facilitate innovation. Examination shows that deregulation in Queensland has the potential to lead to innovation in contracts, but that other antecedents of change are required for this to be effective. The South African MGB appears to implicitly protect the *status quo*. The second part investigated current leadership skills within MGBs and ways of fostering necessary skills. Questionnaire responses were analysed from members of five MGBs. An OLS regression showed respondent perceptions of creative MGB leadership were largely characterised by a competitive win/lose negotiating attribute, which was typified by a communication style that favours withholding information and an adversarial relationship between millers and growers. Changing this mindset among the MGB leadership will require an appropriate leadership development program. However, the most immediate changes required include: conferring of appropriate authority and accountability to MGB leadership to improve communication with outside stakeholders, enabling better application of MGB rules,

improving the MGBs strategic vision, initiating leadership training, and mitigating sectional interests.

COPRODUCTS

The economical viability of animal production based on sugarcane co-products under the present prices of commodities

A. Cabello, A. Torres and O. Almazán
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Animal production from sugarcane co-products is an alternative to diminish hunger and malnutrition in many sugar producing countries and to overcome low sugar prices. Due to the big differences of local market prices and cost considerations of feed, animal products and energy, average international market prices forecast by OECD-FAO have been used. The aim was to evaluate the comparative economical efficiency of milk, beef cattle and swine meat based on bagasse, blackstrap molasses and 'B' molasses respectively according to reported results and compared with their alternative uses. The net value of bagasse for producing milk has been estimated in the range of 20–30$/tonne, and depends heavily on the price of non sugarcane ration components and transportation costs, and is lower than its use for electricity generation at the sugar mill. Blackstrap molasses gives negative revenue when used for fattening cattle as compared with its export price or ethanol production. Swine fattening based on 'B' molasses shows a better revenue than converting it to sugar and blackstrap molasses for export. The obtained values do not take into account important factors affecting the economical revenue of each alternative, but may serve as a primary reference for the use of the sugarcane co-products for different purposes.

Deterioration of molasses during storage: possible cause and means to prevent it

V.M. Kulkarni
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Molasses has sugar content around 50% and, with a Brix above 85, it should not deteriorate during storage. However, it is not uncommon to observe reduction in sugars during storage. Sometimes, this deterioration is accelerated and instances of foaming with or without a rise in temperature are observed, which changes the colour and smell of molasses. There is a rapid reduction in sugars and a rise in acidity. Microscopic observation revealed that the microbial population is very high, and further microbial evaluation confirmed the growth of two bacteria growing in consortium as single bacteria which required a minimum sucrose content of 30% when grown under anaerobic conditions. When this consortium, was broken in aerobic conditions, none of the isolates could tolerate more than 5% sucrose. Their growth and thus molasses deterioration was controlled only with the use of Polmax ESR, a special biocide formulation used with continuous circulation of molasses with cooling. The possible reasons for such infection and efforts to control or avoid such deterioration in some factories will be presented.