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EFFECTS OF LIGHT INTERCEPTION ON SECOND INTERCROP PRODUCTION IN SUGARCANE

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ABSTRACT

An experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm during the 2005-2006 cropping season under irrigated conditions to investigate the possibility of growing mungbean as a sequential intercropping at 90 and 150 cm sugarcane row spacing with sugarcane varieties Isd 31 and Isd 32. Results showed that cultivation of mungbean as the 2nd intercrop with sugarcane leaf clipping had no adverse effects on tillering, millable cane production and cane yield. Irrespective of varieties sugarcane cultivation with leaf clipping at 150 cm row spacing significantly increased fresh plant weight, leaf, grain number and branch production. Leaf clipping had a significant impact on 1000 grain weight, leaf area and other traits of mungbean. It indicates that sugarcane leaf clipping and wider row spacing reduced light interception and allowed higher light availability to mungbean grown as the 2nd intercrop resulting in higher photosynthesis.

Key words: Sugarcane, light interception, sequential intercrop.

INTRODUCTION

Intercropping is a technique to increase unit yield, and interim and higher monetary returns. It helps diversification of crop production to fulfill the diversified needs of farmers (Singh et al. 1986). Sugarcane is a long duration crop and takes about 3-5 months for canopy development since. Generally it is planted in widely spaced rows (one meter apart) which allows for growing intercrops during the early stage of growth. Sugarcane growers take this advantage and grow various short duration crops like potato, onion, garlic, pulses, vegetables etc as 1st intercrops and mungbean, sesame etc as 2nd inter crops to get an interim return since small sugarcane growers can not wait for such a long time to get a financial return from a sole crop of sugarcane. If we suggest them to cultivate more intercrop with sugarcane, they become agree to cultivate this crop. During cultivation in the first intercrop there were no problem between sugarcane and intercrop due to shading effects because vegetative growth of the sugarcane were not enough at this period. But during cultivation in the second intercrop problem of the shading effects arise due to proper vegetative growth of sugarcane. To overcome this problem, we cut the side leaves of the sugarcane so that mungbean can achieve their proper growth. After harvest the second intercrop sugarcane recover their losses fast due to leaf clipping.

For sustainable sugarcane cultivation and to meet national requirements for sugar and gur, it is necessary to find possible ways to increase the economic benefit from sugarcane cultivation. Due to higher demand of cereal and vegetables crops sugarcane cultivation is gradually pushed into the low lying char lands instead of high and medium high lands which is known as flood and water-logged prone areas. Intercropping of economically important short duration winter crops with sugarcane through utilization of present limited land resources would help to sustain sugarcane cultivation in high and medium high lands, and helps to provide an interim return to poor farmers. Besides, it also helps to meet the ever increasing demand for vegetables and pulses for the rising population.

During growth and development, crop plants intercept and absorb growth factors (light, water and nutrients) and use them to produce biomass (Trenbath, 1986). Some parts of this biomass is the harvestable yield. The required growth factors are distributed variously in space and time. Therefore, crop complementary and supplementary relations determine the magnitude of intercrop competition (Ofori and Gamedoaghao, 2005). In an intercropping system involving legume crops, a supplementary relation would exist due to nitrogen fixation. Consequently, mungbean may not suffer competitions for N supplies when grown with sugarcane.

Higher yield advantage can be realized in an intercropping system when growth patterns in terms of time (growth rapidity and maturity period) and space (plant architecture) of component crops (Ghosh *et al.,* 2006) are complementary. Complementarities would also occur when growth patterns of component crops in an intercrop system differ in critical periods of high demand for resources (Iragavarapu and Randall, 1996). Complementary relations between sugarcane and mungbean may be weak due to differences in growing pattern and plant architectural traits. Sugarcane and mungbean are plants with different architecture and likely they are probably not in critical competitions for light interception during the initial critical fast growth period. Kabir (1988) observed that potato, mustard and gram are most compatible first intercrops with sugarcane and helped to reduce the cost of sugarcane cultivation. To sustain intercrop cultivation it needs to be more intensive-cum-remunerative through sequential intercrop production and it is important to identifying factors affecting intercrop cultivation. As such studies are needed on the interaction between canopy development and light interception especially on sequential intercrops cultivation. Therefore, an experiment was carried to study the effects of light interception on 2nd intercrop mungbean cultivation with sugarcane.

MATERIALS AND METHODS

A field experiment was conducted at the Bangladesh Sugarcane Research Institute (BSRI) farm, Ishurdi, Pabna during the 2005-2006 cropping season under irrigated conditions. A randomized complete block design with three replications was used. Polybag settlings of varieties Isd 31 and Isd 32 were transplanted at two row to row spacings viz 90 cm and 150 cm and plant to plant spacing was varied to maintain the same initial plant population per unit area. In case of the second intercrop mungbean (variety BINA Mung-5) was used. The unit plot size was 9× 4 m. Fertilizers used for sugarcane were @ 325, 250, 185, 165 kg ha^{-1} as Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP) and Gypsum respectively. No fertilizer was used for intercrop mungbean. Cultural practices such as gap filling, weeding, mulching, tying etc were done as and when required.

The treatments for the experiment were as follows:

T_1 = Sugarcane (Isd 31; Row spacing 90 cm) + Mungbean with sugarcane leaf clipping (SLC).
T_2 = Sugarcane (Isd 31; Row spacing 90 cm) + Mungbean without SLC
T_3 = Sugarcane (Isd 31; Row spacing 150 cm) + Mungbean with SLC
T_4 = Sugarcane (Isd 31; Row spacing 150 cm) + Mungbean without SLC
T_5 = Sugarcane (Isd 32; Row spacing 90 cm) + Mungbean with SLC
T_6 = Sugarcane (Isd 32; Row spacing 90 cm) + Mungbean without SLC
T_7 = Sugarcane (Isd 32; Row spacing 150 cm) + Mungbean with SLC
T_8 = Sugarcane (Isd 32; Row spacing 150 cm) + Mungbean without SLC

Seeds of mungbean were sown between vacant spaces of sugarcane on 15 March 2006. Irrigation was done on 16 March 2006. Side leaves of the cane between the rows of mungbean were cut with scissors. Data were collected on yield and various yield contributing parameters of cane and mungbean was done. Tiller production of sugarcane was recorded at an interval of 15 d. Millable canes and yield was recorded at harvest. Statistical analysis on different parameters for sugarcane and mungbean were done following standard procedures.

RESULTS AND DISCUSSION

The tiller population and millable canes productions were significantly influenced by different treatment in the present investigation (Table. 2). The highest tiller population (173.2×10^3 ha^{-1}) was recorded where sugarcane variety Isd 31 was planted at sugarcane row spacing 90 cm and mungbean with SLC treatment followed by treatment where sugarcane variety Isd 31 was planted at row spacing of 90 cm with mungbean without SLC. A similar trend was also observed in the case of millable cane production. The lowest number of tillers and millable canes were recorded at treatment (T_8) where mungbean was grown as the 2nd intercrop with sugarcane variety Isd 32 at row spacing 150 cm with or without SLC. These results indicate that sugarcane leaf clipping has no adverse effects on tiller and millable cane production and 150 cm row spacing reduced tiller and millable cane production in sugarcane. Tiller and millable cane production not only depends on spacing but on varietal characters, and present findings confirmed findings of Rahman *et al.,*(1987). Ali *et al.,* (1989) observed greater tiller and millable cane production at 90 cm row spacing compared to 100 cm row spacing. Kashem *et al.,* (2005) reported the lowest number of millable cane in variety Isd 32 compared to all other varieties.

Cane yields for the various treatments are presented in table 2, and it may be seen that the highest cane yield (95.4 t ha^{-1}) was obtained at treatment (T_5) where sugarcane variety Isd 32 was planted at row spacing 90 cm and mungbean was grown with SLC, while the lowest cane yield (73.8 t ha^{-1}) was recorded at treatment ($T_{4)}$ where sugarcane variety Isd 31 was grown with mungbean as 2^{nd} intercrop without sugarcane leaf clipping at 150 cm row spacing. Sugarcane yield varies with variety grown and row spacing used in the experiment. This finding agrees with the finding of Rahman (2006) where they obtained the highest cane yield in variety Isd 32 and the lowest yield in variety Isd 31.

Results of mungbean production as the second intercrop are shown in the Table1. It is seen from the table 1 that significantly higher leaf area, fresh and dry weight of plant, number of pods/plant, number of grains/pod, branches/plant, sundry weight of grain and 1000 grain weight were recorded where mungbean was grown as 2^{nd} intercrop at 150 cm row spacing of sugarcane variety Isd 31 with SLC followed by the treatment (T_7) where sugarcane variety Isd 32 was grown at row 150 cm spacing with SLC. It is seen from the Table 1 that leaf clipping has a positive impact on different yield parameters of mungbean. Leaf clipping allows more light and reduces light interception which results in higher mungbean yield as well as yield contributing characterstics of mungbean irrespective of sugarcane variety.

The highest yield of mungbean was obtained from treatment (T_3) where sugarcane variety Isd 31 was planted at row spacing 150 cm and mungbean was grown in the interspace with sugarcane leaf clipping followed by treatment (T_7) where sugarcane variety Isd 32 was planted at row spacing 150 cm and mungbean was grown at in the interspace with sugarcane leaf clipping. The lowest yield of mungbean was obtained from the treatment (T_2) where sugarcane variety Isd 31 was planted at row spacing 90 cm and mungbean was grown in the interspace without sugarcane leaf clipping. These results indicate that mungbean yield significantly increased due to sugarcane leaf clipping, and comparatively higher row spacing. It is also seen that mungbean yield decreased due to no sugarcane leaf clipping and narrow row spacing. Miah *et al.*, (2002) reported that narrow interspaces between two sugarcane rows influenced light interception resulting in a higher level of shading on 2nd intercrops, and the process of photosynthesis was affected. To get proper productivity in light sensitive intercrops like mungbean needs wider interspaces are required to give adequate solar radiation for proper photosynthesis to contribute to the ultimate yield of the 2nd intercrop.

Plant architectural traits, therefore, are important factors to provide complementarities when intercropping. Selection for improved yield under sole cropping may not necessarily lead to improved yield under intercropping and different plant traits may be more appropriate for cultivars intended for use under intercropping than for those intended for use under sole cropping (Magdy *et. al.*, 2007). Some intercrops faced considerable competition for nutrient supplies from the soil. The yield of mungbean and sugarcane intercropping suggests that mungbean was not a strong competitor to sugarcane. In conclusion, a reasonable additional crop outcome could be realized by intercropping of mungbean with sugarcane as main crop. To benefit from this added crop, it is recommended that wider interspaces be used to receive the required solar radiation for optimum photosynthesis. Analyses of yield components revealed that greater light interception during the vegetative and early reproductive periods was responsible for increased yield with wider row spacing combined with sugarcane leaf clipping.

Table-1 Effects of sugarcane row to row spacing and sugarcane leaf clipping on yield contributing parameters of mungbean grown as 2nd intercrop

Yield Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**
Number of plants/m2	34.7b	32.9c	36.7a	36.3a	33.5bc	33.3bc	36.3a	37.4a
Leaf area (cm^2/plant)	567.8e	539.6g	816.8a	747.9c	551.7f	531.0h	798.0b	715.6d
Fresh weight of plant (g plant^{-1})	18.8e	17.5f	34.9a	31.0c	19.0e	16.4g	32.b	29.1d
Sundry weight of plant (g plant^{-1})	5.8f	5.1g	8.2a	7.3c	6.2e	6.1e	7.9b	6.8d
Number of pod/plant	6.7e	6.0g	9.9a	7.8c	6.2f	6.8e	8.6b	7.6d
Number of grain/pod	6.6e	6.2f	9.6a	8.6b	6.8d	6.2f	8.8b	8.1c
Number of leaf/plant	7.0d	6.7e	10.8a	9.7b	7.2d	6.7e	10.9a	9.3c
Number of branch/ plant	1.1de	1.0e	1.7a	1.3c	1.1de	1.2d	1.6b	1.2d
Sundry weight of Grain/plant (mg plant^{-1})	1092.6f	1033.1g	1511.6a	1187.2d	1153.1e	1003.7h	1469.3b	1398.9c
1000 grain weight (g)	26.9g	26.53h	36.7a	33.8c	27.9f	29.6e	34.6b	32.1d

Figures followed by common letters are not significant in the same row.

Table-2 Effects of row spacing and sugarcane leaf clipping on tiller, millable cane, sugarcane yield and mungbean yield

Treatments	**Tiller (10^3ha^{-1})**	**Millable cane (10^3ha^{-1})**	**Sugarcane yield (t ha^{-1})**	**Mung bean yield (t ha^{-1})**
T_1	173.2a	111.4a	77.83e	0.35
T_2	172.4a	110.5a	76.90e	0.31
T_3	166.2b	103.5b	74.50f	0.51
T_4	165.5b	102.7b	93.80bc	0.42
T_5	152.2c	96.50c	95.47a	0.37
T_6	151.9c	72.17e	94.57ab	0.35
T_7	143.2d	94.70d	93.20cd	0.46
T_8	142.6d	93.90d	92.50d	0.44

Figures followed by common letters are not significant in the same column.

REFERENCES

1. Anonymous.2005. Cultivation methods of BINA Released varieties/technologies (Bengali version). Published by Bangladesh Institute of Nuclear Agriculture, P.O. Box-4, Mymensingh.p.62.
2. Afzal, M. A., A. N. M. M Murshad, M. A. Bakar, A. Humid, and A B. M. Salahuddin, 1998. Mungbean cultivation in Bangladesh. Published by Pulse Research Station, BARI, Gazipur-1701, Bangladesh. p. 25.
3. Ali, M., A.H.M.D. Hossain, S. A. Imam, and M. Shaheen, 1989. Row adjustment of sugarcane on the yield of intercropping cane and potato. Bangladesh J. S. cane, 11:78-82.
4. Ghosh, P. K. M .Mohanty, K. K. Bandyopadhyay, K. K. Painuli and A. K. Misra. 2006. Growth, competition, yield advantage and economics in soybean/ pigeonpea intercropping system in semi-arid tropics of India: I. Effect of sub soiling. Field Crop Res., 96:80-89.
5. Iragavarapu, T. K. and G. W. Randdall. 1996. Border effects on yields in a strip-intercropping soybean, corn and wheat production system. J. Prod. Agric, 9:101-107.
6. Ofori, K. and D. K. Gamedoaghao. 2005. Yield of scarlet eggplant (*Solanum aethiopicum* L.) as influenced by planting date of companion cowpea. Scientia Horticulture 105: 305-312.
7. Kabir, M. H. 1988. Economics of intercropping with sugarcane in selected areas of North Bengal Sugar Mills Zone. Bangladesh J. Sugarcane, 10:41-86.
8. Kashem, M. N.; Ahmed, T.; Jabber, M.A. and Abdullah, M. 2005. Performance of some selected varieties in farmers field condition under Tista Meander Floodplain Soils. Bangladesh J. Sugarcane, 24-27: 98-101.
9. Matin, M. A., M. L. Kabir, M. J. Alam, and A.K.M.M. Zaman. 2001. Performance of winter vegetables and summer mung as intercrops with paired row transplanted sugarcane. Bangladesh J. Sugarcane, 23:7-14.
10. Miah, M.A.S., A.B.M.M. Rahman, M.A. Hossain, M.K.A. Chowdhury, M.R. Alam, and S. Ali, 2002. Paired row planting technique and sequential intercropping in sugarcane. Pak Sugar Journal May-June.p.1-6.
11. Magdy, A. A., M. Mohamed, F. Mohamed, H. Mohamed, Dokashi and F. Emad- Elden; Elnobi, E. 2007. Intra row intercropping of cowpea and cucumber with okra as influenced by planting date of secondary crops. Ass. Univ. Bull. Environ. Res. 10: 1-16.
12. Rahman,A.B.M..M., M.A. Matin, and M.Y. Ali. 1987. Tillering and productivity of autumn and summer transplanted sugarcane. Bangladesh J. Sugarcane, 9: 1-8.
13. Rahman, M. S. 2006. Performance of some newly released sugarcane varieties in Rajshahi Sugar Mills growers field under high Barind tract of Bangladesh. International journal of Sustainable Agricultural Technology. 2 (4): 69-71.
14. Singh,V., S. K. Kothari, and H.N. Tripathi. 1986. Studies on intercropping in sugarcane in Central Uttar Pradesh. Indian Sug. J, 35:559-562.
15. Trenbath, B.R. 1986. Resource use by intercrops. P.57-81, In: Charles A. Francis (Ed.), Multiple Cropping Systems Macmillan Publishing Company, New York. pp383.

EVALUATION OF SOME SUGARCANE CLONES AT FAISALABAD

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ABSTRACT

A field experiment was planned with the objective to evaluate performance of ten sugarcane clones namely S2002US-234, S2002US-312, S2002US-447, S2002US-452, S2002US-463, S2002US-628, S2002US-635, S2002US-747, SPF-213 (standard) and HSF-240 (standard) under semi arid climatic conditions of Faisalabad. Statistically significant results showed that clone S2002US-312 crossed all its counter parts, including standards, by producing maximum cane yield (101.77 t/ha), CCS (13.84%) and sugar yield (14.08 t/ha). The remaining clones recorded significant and variable results with respect to germination, tillering, number of millable canes, cane yield and sugar yield.

Key words: Sugarcane, clones, CCS, sugar yield, cane yield.

INTRODUCTION

Sugarcane is an important cash crop and plays a vital role in the country's economy. Millions of people are engaged in sugarcane production, industrial processing and trade (Bashir *et al.,* 2005). In Pakistan, a slight increase in cane yield (0.69%) has been recorded its annual yield was 48887 Kgs/ha during 2004-05 which increased up to 49229 kgs/ha in 2005-06 (GOP, 2006). However this small increase is not enough to meet the nation's sugar demand. Low cane yield may be due to poor management, low seed rate, poor quality seed, and low yielding varieties both in tonnage and quality limit production to a considerable extent (Ahmad, 1998). Low rate of sugarcane productivity and sucrose recovery can be attributed to low yielding varieties (Afghan *et al.,* 1994). Sugarcane varieties show great variation in expression of genotypic and phenotypic characters in various sets of ecological conditions (Malik *et al.,* 1993). Unawareness of farmers in adaptation of varieties is also the prime cause of low cane yield (Jamro *et al.,* 2000). So there is a dire need to evaluate high yielding varieties with the course of time. The studies made in the past regarding the topic is given below.

Aslam *et al.*, (1998) recommended a new cane variety SPF-234 for cultivation in southern Punjab of Pakistan after comparing nine clones in that region. SPF-234 germination (38.48%), tillers per plant (3.32), cane weight (1.25 kg) cane stand (111296 canes/ha), cane yield (139.43 t/ha) and sugar yield (14.06 t/ha). Singh *et al.,* (1992) compared different agronomic characteristics of twelve promising sugarcane varieties under rainfed conditions and found Cos 8118 and B091 best as it produced 78.2 and 73.9 t/ha millable tillers respectively. Ricaud and Domaigue (1991) studied the performance of some newly introduced and standard commercial cultivars in Mauritius and recommended cv. M1658/78 as the excellent variety because of its higher yield and sucrose contents as well as its wide adaptation to different soils and climatic regions of island. Rehman *et al.,* (1989) studied qualitative and quantitative characteristics of eleven sugarcane varieties and declared BF-162 as the best in cane and sugar yield over the other varieties compared. Alvarez *et al.,* (1989) recommended five varieties namely IAC-58/243, IAC-69/307, IAC-363, IAC-68/245 and IAC-69/426 among twenty five varieties studied by him.

Keeping in view the above research works the present studies of some important sugarcane clones was made under semi arid climatic conditions of Faisalabad.

MATERIALS AND METHODS

A one year field trial was undertaken to evaluate the performance of ten sugarcane clones under the agro-climatic conditions of Faisalabad. Sowing and harvesting of crop was done in the month of March each year respectively. The crop was sown@70,000 DBS/ha in deep trenches in which fertilizers NPK were applied @ 168-112-112 Kgs/ha. All potash and phosphate fertilizers were applied at the time of sowing while nitrogenous fertilizers were split into three doses. Plant protection measures, cultural operations and other agronomic practices were adopted as and when considered necessary. The data regarding germination and tillering were recorded after one and half month and three months of sowing while all other parameters, excluding CCS, were recorded at harvest. CCS was determined from the samples harvested after one month interval during crushing season from October to April by the methods described in laboratory manual (Anonymous, 1970). After completing the process of laboratory and field analysis, the data thus collected were subjected to statistical analysis to compare the superiority of means using LSD at 5% probability level for testing significance differences as suggested by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The results of the study are packed in Table. The brief discussion of studied characters is given in the coming lines one by one.

Germination

It is the most critical factor because it plays a potential role in establishing cane stand in the field. The data given in table indicated that differences in the clones were significant for germination. A perusal of data indicated that maximum germination (40.19%) was recorded in case of S2002US-747 followed by S2002US-463, S2002-452, S2002-US-628, S2002US-635, S2002US-312, S2002US-447 and S2002US-234 producing germinates as 38.48%, 33.58%, 31.62%, 30.76%, 30.02%, 21.81% and 21.20% respectively when eight clones were compared with standard HSF-240, however all clones failed to produce higher germinants than SPF-213 (53.77%). Highly variable germination among different cane cultivars was also recorded by Agrawal *et al.*, (1991).

Tillers per plant

The extent and nature of tillering till maturity depends upon planting technique, water, nutrient availability and a number of other external and internal factors. As far as tillering data is concerned, significantly variable tillering differences were observed among all clones. A situation similar contrary to germination was observed in tillering where no clone could generate higher number of tillers per plant when compared with early maturing standard HSF-240. But six clones namely S2002US-635, S2002US-628, S2002US-452, S2002US-463, S2002US-747 and S2002US-312 showed higher number of tillers per plant 3.03, 2.73, 2.52, 2.42, 2.31 and 2.26 when compared with medium and late maturing standard SPF-213 (2.14). Variable tillering for different cane clones was also described by Tai *et al.*, (1995).

Number of millable canes

It is the interaction as well as combination of germination, tillering, resistance against pests and pathogens. The data relating to number of millable canes indicated significant differences among different cane clones. The tabulated data exhibited significant differences among clones showed that only two clones S2002US-628 and S2002US-463 in which higher number of millable canes than standards. Both the standards produced equal number of millable canes i.e. 101.74 000/ha. S2002US-628 and S2002US-463 were also statistically at par with SPF-213 and HSF-240. The minimum cane count (30.12 000 /ha) was noticed in S2002US-234. Ali *et al.,* (1999) made similar studies of some sugarcane varieties.

Cane yield

Cane yield is the most desirable character which correlates with the fresh weight harvested. The data related to cane yield shows significant differences among all clones. Four clones yielding canes above SPF-213 were S2002US-312 (101.77 t/ha), S2002US-452 (101.39 t/ha), S2002US-463 (98.61 t/ha) and S2002US-628 (93.40 t/ha). The former three clones also crossed HSF-240 with respect to cane yield. This explanation is in harmony with those described by Nanda *et al.,* (1994).

CCS

Commercial cane sugar provides the quality and maturity judgment for a variety. It is evident from data table that all the clones showed variable results with respect to CCS. The data revealed that six clones namely S2002US-312, S2002US-452, S2002US-447, S2002US-463, S2002US-635 and S2002US-747 gave higher CCS as 13.84%, 12.82% 12.35%, 12.01%, 11.94% and 11.82% than standard SPF-213. The first two clones S2002US-312 and S2002US-452 revealed higher commercial cane sugar than standard HSF-240. Nuss (1993) elucidated the same facts.

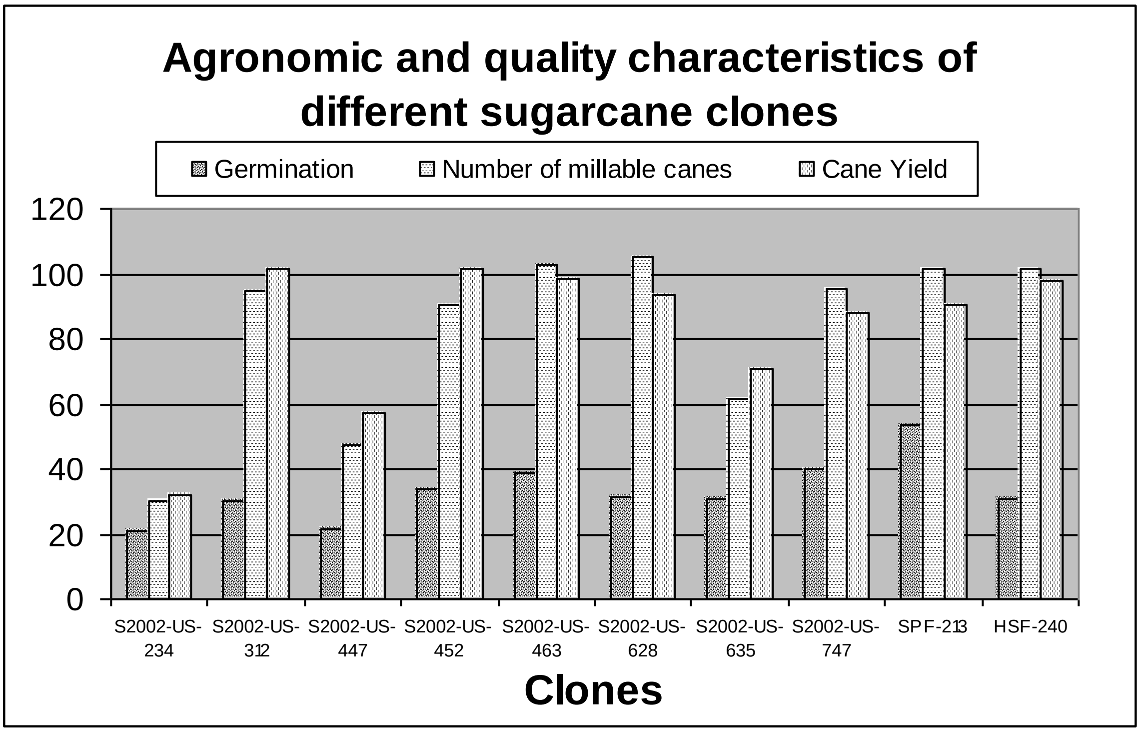
Sugar yield

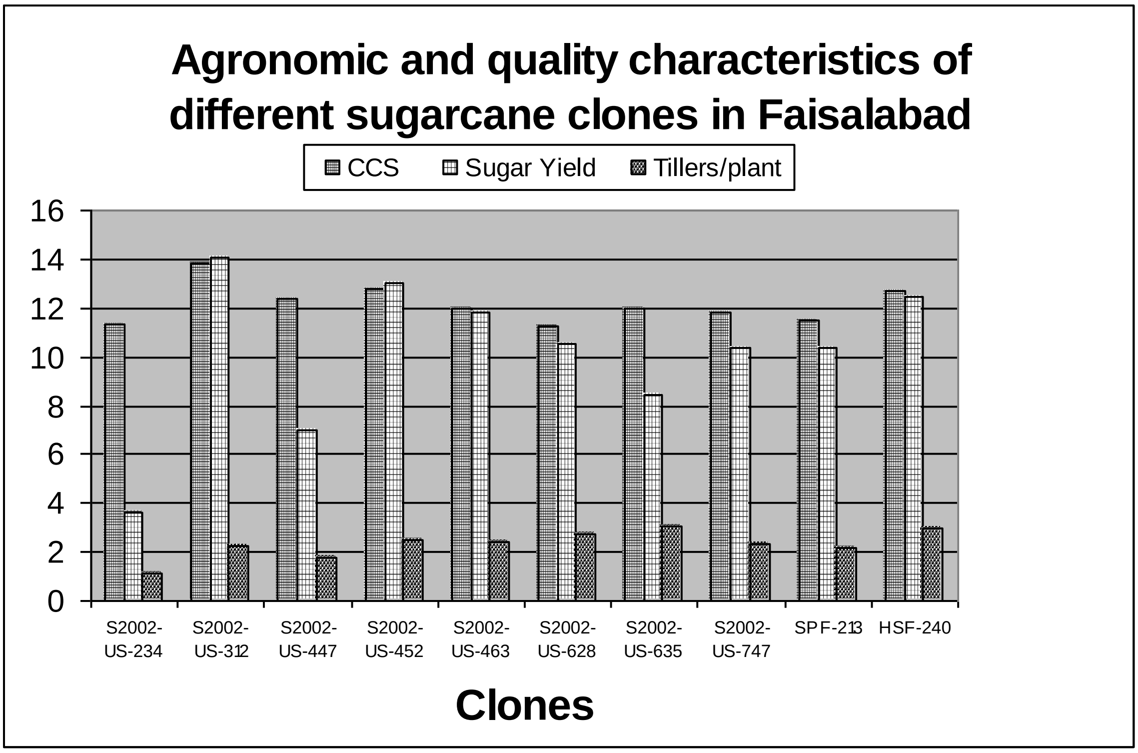
It is obtained from the combination of stripped cane yield and corresponding recoverable sugar percentage. The tabulated data indicated that sugar yield of five clones S2002US-312, S2002US-452, S2002US-463, S2002US-628 and S2002US-747 was higher than medium and late maturing standard SPF-213 while S2002US-312 and S2002US-452 yielded higher sugar than early maturing standard HSF-240. These data trend are in line with those reported by Singh *et al.,* (1993).

Table Agronomic and quality characteristics of different sugarcane clones

Sr. No.	Clones	Germination (%)	Tillers plant^{-1}	Millable canes (000/ha)	Cane yield (t/ha)	CCS (%)	Sugar yield (t/ha)
	S2002-US-234	21.20e	1.15c	30.12f	31.78e	11.33	3.60e
	S2002-US-312	30.02d	2.26ab	94.86bc	101.77a	13.84	14.08a
	S2002-US-447	21.81e	1.73bc	47.31e	56.94d	12.35	7.02d
	S2002-US-452	33.58bcd	2.52ab	90.62c	101.39a	12.82	13.00ab
	S2002-US-463	38.48bc	2.42ab	102.78ab	98.61ab	12.01	11.84bc
	S2002-US-628	31.62cd	2.73a	105.21a	93.40ab	11.24	10.50c
	S2002-US-635	30.76d	3.03a	61.72d	70.49c	11.94	8.42d
	S2002-US-747	40.19b	2.31ab	95.14bc	87.85b	11.82	10.38c
	SPF-213 (std.)	53.77a	2.14ab	101.74ab	90.28ab	11.52	10.40c
	HSF-240 (std.)	30.35d	2.94a	101.74ab	97.92ab	12.69	12.43b
	LSD at 5%	7.161	0.9254	9.840	12.05		1.475

Std. = Standard
LSD = Least significant difference


Agronomic and quality characteristics of different sugarcane clones
Germination
Number of millable canes
Cane Yield
120
100
80
60
40
20
0
S2002-US-234
S2002-US-312
S2002-US-447
S2002-US-452
S2002-US-463
S2002-US-628
S2002-US-635
S2002-US-747
SPF-213
HSF-240
Clones


Agronomic and quality characteristics of different sugarcane clones in Faisalabad
CCS
Sugar Yield
Tillers/plant
16
14
12
10
8
6
4
2
0
S2002-US-234
S2002-US-312
S2002-US-447
S2002-US-452
S2002-US-463
S2002-US-628
S2002-US-635
S2002-US-747
SPF-213
HSF-240
Clones

REFERENCES

1. Afghan, S., S.A. Qureshi and N.M. Nasir. 1994. Performance of SPSG-26, a newly developed variety at Shakarganj Sugar Res. Institute, Jhang. Pak. Sugar J.VIII (2):7-11.
2. Agrawal, M.L., R.K. Singh, M. Singh and B.S. Teotia. 1991. Performance of some promising sugarcane cultivars under late planting in western Uttar Pradesh. Indian Sugar. 41(9):673-676.
3. Ahmad, N.1988. Studies on Comparative decline in yield potential & quality of some old sugarcane varieties. M.Sc. (Hons) Agri. Thesis, Deptt. Agron., Univ. of Agric., Faisalabad.
4. Ali, F.G., M.A. Iqbal and A.A. Chattha. 1999. Performance of some sugarcane varieties in western Punjab. Pak. Sugar J. XIV (06): 6-8.
5. Alvarez, R.C.V., C.D. Pommer, O.Bastos, G.G. Junior and B.Bovi. 1989. Sugarcane Breeding IV. Regional Triats of Clones established in 1989. Bragntie, 43(11): 166-156.
6. Anonymous. 1970. Laboratory Manual for Queensland Sugar Mills. 5th Edition. Burean of sugar experiment station, Queensland:2.
7. Aslam, M., M.A. Javed and K.B. Malik. 1998. Comparative Performance of a promising cane variety SPF-234 in southern Punjab. Pak. Sugar J.13(2):5-10.
8. Bashir, S., A.A. Chattha, M. Yasin and Z. Mehmood. 2005. Sugarcane varieties and row spacing effect on sugarcane triats. Pak. Sugar J. XX (2): 18-19.
9. Government of Pakistan. 2006. Agricultural statistics of Pakistan. Ministry of Food, Agriculture and Livestock. (Economic wing).
10. Jamro, G.H., A.M. Kumbhar, A. Ullah and A.G. Soomro. 2000. To study the performance of different sugarcane varieties under climatic conditions of upper Sindh. Sarhad J. Agric. 16(5):515-519.
11. Malik, K.B., S. Bashir and A.R. Zahid. 1993. Performance of some regional cane varieties under Faisalabad conditions. Pak. Sugar J. VII (1):3-6.
12. Nanda, S.S., B.P. Gantayat and B.Dash. 1994. Varietal reaction of sugarcane in west central table land zone of Orissa. Orissa Journal of Agricultural Research. 6(1-2):101-103. [Field Crop Absts, 48(5), 1995].
13. Nuss, K. 1993. A new variety is released. S. African Sug. J. 77(10):284. [Field Crop Absts, 47(10), 1994].
14. Rehman, S., G.S. Khan and I.U. Khan. 1989. Coordinated uniform national varietal trial on Sugarcane. Pak. Sugar J., 32(8):519-521.
15. Ricaud, C. and R. Domaingue. 1991. [Agronomic performance of sugar cultivars at the final stage of selection.] Performance des varieties de canne a sucre aux stades finals de la selection. Revue Agricola et sucriere de L' LLe Maurice 70(1-2):6-25. [Field Crop Absts, 46(7), 1993].
16. Singh, S., P.S. Verma. M.M.S. Saxena and B.D. Singh. 1993. CoS 90265-an early high sugar variety for U.P. Indian Sugar. 43(1):31-33.
17. Singh. I., R.S. Singh, R.V.S. Chauhan and S.B. Singh. 1992. Sugarcane varietal evaluation under rainfed condition Indian Sugar. 42(6):359-362.
18. Steel, R.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. Mc. Graw Hill Book Co. New York, U.S.A.
19. Tai, P.Y.P., J.D. Miller, C.W. Deren, B.Glaz, J.J.M. Shine and J.C. Comstock. 1995. Registration of 'CP 85-1308' sugarcane. Crop Sci. 35(4):12-13. [Field Crop Absts, 49(3), 1996]

INFLUENCE OF NPK ON ADVANCED PROMISING CLONES OF SUGARCANE AT TWO DIFFERENT AGRO-ECOLOGICAL ZONES OF BANGLADESH

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ABSTRACT

The field experiments were conducted to evaluate the effects of varying levels of N, P and K on three promising sugarcane clones and one standard variety at High Ganges River Floodplain (AEZ 11) and Old Himalayan Piedmont Plain (AEZ 1) soils of Bangladesh. Results revealed that sugarcane clones and N and K significantly differed with yields, yield attributes of cane in both the agro-ecological zones but P fertilization effects were not differed significantly. N application increased cane yield 89% and 30% over control at High Ganges River Floodplain (AEZ 11) and Old Himalayan Piedmont Plain (AEZ 1) soils, respectively without effecting sucrose content. P and K application had significant effect to increase cane yield and recoverable sugar. In order to yield potentiality, the studied clones followed the order: I 486-99 > I 139-98 >I 82-98 at High Ganges River Floodplain and I 486-99 > I 82-98 > I 139-98 at Old Himalayan Piedmont Plain. It was found that clone I 486-99 with 200 kg N, 50 kg P, 60 kg K ha^{-1} at High Ganges River Floodplain (AEZ 11) and 120 kg N, 35 kg P, 100 kg K ha^{-1} at Old Himalayan Piedmont Plain (AEZ 1) soils produced better yield because of its inherent capability and adaptability in two agro-ecological zones of Bangladesh.

Key words: Sugarcane, clone, nitrogen, phosphorus and potassium

INTRODUCTION

Sugarcane is one of the most important food-cum-cash crops in Bangladesh. It is a long durable exhaustive crop. It requires high amount of nutrients for its growth and development. Sustainable sugarcane production depends on better management with the nutrient content of the soil and crop demand. Our land resources are limited; the increased target of cane production has to be achieved by raising the productivity of cane per hectare and improving its quality. Sugarcane varieties differ in nutrient requirement from place to place according to soil and agro-climatic conditions (Davidson, 1962; Raghaviah and Singh, 1980; Trivedi and Saini, 1986). Some varieties have ability to absorb and utilize more nutrients from a soil under the same climatic condition and produce more cane and sugar (Humbert, 1968). The application of balanced dose of NPK produced the maximum cane yield. Increased yield of sugarcane was obtained from application of N, P, K to most soils (Tabayoyong and Robeniol, 1962). The application of NPK beyond 100 per cent of the recommended dose had produced only marginal increase in cane and sugar yield (Alexander *et al.*, 2003). Fertilizers play an important role in increasing sugar production mainly because of their influence on cane tonnage. Most cane growers use fertilizers regularly to maintain or gain further increase in cane yields per acre. This primary importance of nitrogen fertilizer in maintaining cane tonnage has been well recognized by cane growers of the world (Bokhtiar, 2004). Clones for sugarcane production should contain high sucrose with fewer amounts of non-sugars and should have capacity to withstand adverse environment. Yield potentiality of a crop would not reach a maximum unless proper fertilizer management is made. Sugarcane variety shows a tendency to decline in yield and vigor which needs replacement of the existing varieties with the new ones. Thus, it is necessary to determine the optimum doses of N, P and K fertilization for advanced promising clones of sugarcane achieving maximum yield and better quality.

MATERIALS AND METHODS

A study with three separate experiments was conducted at Bangladesh Sugarcane Research Institute experimental farm under High Ganges River Floodplain soils (AEZ 11) and another at Regional Sugarcane Research Station farm (RSRS), Thakurgoan under Old Himalayan Piedmont Plain soils (AEZ 1) during 2005-2006 cropping season. The soil of the experimental site at High Ganges River Floodplain is clay loam with medium high land having pH 7.8, low in total N 0.05 per cent, available P 6.00 ppm, K 0.16 meq % and S 17.70 ppm; and at Old Himalayan Piedmont Plain is sandy loam with pH 5.00, low in total N 0.07 per cent, available P 11.00 ppm, K 0.15 meq % and S 9.00 ppm. The climate of these locations is sub-tropical. Forty-five days old two budded soil bed settling of the studied clones/variety (I 82-98, I 139-98, I 486-99 and one standard variety Isd 32) were used as test materials. It was transplanted in November and harvested after 13 months at the maturity of the crop. The experiments were laid out in split plot design with three replications. Two factors with clones/variety and nutrient were involved in the experiment. The unit plot size was 5m × 4m having row to row and plant to plant distance of 100 cm and 50 cm, respectively. The recommended management practices were followed.

In the first experiment, four levels of nitrogen (0, 100, 150, 200 & 250 kg N ha^{-1} at Bangladesh Sugarcane Research Institute farm and 0, 80, 120, 160 and 200 kg N ha^{-1} at RSRS, Thakurgaon farm) as urea were applied in three splits; first at settling establishment stage (25 days after transplanting), second at tiller initiation stage (120 days after transplanting) and third at peak tillering phase (160 days after transplanting). Full recommended rates of triple super phosphate, gypsum, zinc sulphate and one third of muriate of potash were applied in the cane furrows as basal and mixed thoroughly with soils to supply P, S, Zn and K, respectively. Remaining two third of muriate of potash were applied in two splits as top dressed at 120 and 160 days of transplantation.

The second experiment comprised of four phosphorus levels (0, 30, 50, 70 and 90 kg P ha^{-1} at Bangladesh Sugarcane Research Institute farm and 0, 20, 35, 50 and 65 kg P ha^{-1} at RSRS, Thakurgaon farm) from triple super phosphate. Full amount of phosphorus was applied in trenches as basal and mixed with soil at the time of transplanting. Recommended rates of N, K, S and Zn were applied as was done in the first experiment.

The third experiment included four level of potassium (0, 60, 90, 120 and 150 kg K ha^{-1} at Bangladesh Sugarcane Research Institute farm and 0, 70, 100, 130 and 160 kg K ha^{-1} at RSRS, Thakurgaon farm) as murate of potash. Potassium fertilizer was applied in three installments as stated in the first experiment. The all other fertilizers were applied in the plots as per same sequence like two other experiments. Data were subjected to statistical analysis and the significance of mean difference was calculated following least significance difference (LSD) test at 5% level.

RESULTS AND DISCUSSION

Effect of N on Sugarcane Clones:

Yield and yield attributes

In N experiment results revealed that nitrogen fertilization had a highly significant effect on tiller, millable cane stalk, yield and height of cane but it was insignificant on diameter and pol per cent cane at High Ganges River Floodplain soils (Table 1a). It was found that all the treatments of nitrogen increased cane yield significantly over control. Yield was increased up to 250 kg N ha^{-1} for every increment of 50 kg N from 100 kg N ha^{-1}. The highest yield was obtained from 250 kg N ha^{-1} (50.89 tha^{-1}) followed by 200 kg N ha^{-1} (47.68 tha^{-1}), however the effect was statistically identical. Again 150 kg N ha^{-1} showed statistically similar yield with 200 kg N ha^{-1}. The increase in cane yield was 55.77%, 78.85%, 104.50% and 118.22% with 100, 150, 200 and 250 kg N ha^{-1}, respectively over control. Alam *et a*l., (2006) observed that increasing in cane yield was 46%, 58% and 69% due to 100, 150 and 200 kg N ha^{-1}, respectively over control. The highest number of tiller (72.33 □ 10^{3} ha^{-1}) and millable cane (68.88 □ 10^{3} ha^{-1}) were found at the rate of 250 kg N ha^{-1} followed by 200 kg N ha^{-1} (68.58 □ 10^{3} ha^{-1} and 64.88 □ 10^{3} ha^{-1}, respectively). Tiller and millable canes obtained at the rate of 150 kg N ha^{-1} (63.79 □ 10^{3}ha^{-1} and 60.75 □ 10^{3} ha^{-1}, respectively) was statistically similar with that in 200 kg N ha^{-1} (Table 1a). However, the effect was identical for the application with 150 and 200 kg N ha^{-1}. The highest cane height (2.77 m) was recorded with the application of 250 kg N ha^{-1} which was statistically similar cane height with 200 kg (2.71 m), 150 kg (2.62 m) and 100 kg (2.64 m) N ha^{-1}. From the above results (Table 1a) it may be concluded that the application of 200 kg N ha^{-1} produced batter cane yield and positively affecting yield contributing parameters.

Among the varieties; the tiller, millable cane, height and diameter were also differed significantly whereas yield and pol percent in cane did not have significant difference (Table 1a). The variety Isd 32 produced the highest number of tiller (69.20 □ 10^{3} ha^{-1}) and millable cane stalk (65.37 □ 10^{3} ha^{-1}), respectively. The highest height of cane (2.78 m) and diameter (2.16 cm) were found in I 486-99 followed by Isd 32 (2.66 m and 2.12 cm, respectively). The lowest cane height (2.53 m) and diameter (1.92 cm) were obtained in I 82-98 and I 139-98. There was a significant interaction effect of nitrogen and variety on yield of sugarcane (Fig. 1).

On the other hand, from the Old Himalayan Piedmont plain soils it was found that every 40 kg increment of N doses from 80 kg N ha^{-1}, yield was increased up to 200 kg N ha^{-1} (Table 1b). The highest percentage of yield increase (37%) was obtained from 200 kg N ha^{-1} among the N applications. Application of nitrogen at the rate of 120 kg ha^{-1} (38.75 tha^{-1}) was statistically identical with 160 kg N ha^{-1} (38.50 tha^{-1}) and 200 kg N ha^{-1} (39.46 tha^{-1}) in respect of yield. Increasing in cane yield was 24%, 35%, 33% and 37% due to 80, 120, 160 and 200 kg N ha^{-1}, respectively over control. Rahman *et al.*, (1989 and 1993) stated that N application increased cane yield by 20, 45, and 10% at farms of Sugarcane Research and Training Institute (SRTI), Jaipurhat Sugar Mill (JSM) and Kaliachapra Sugar Mill (KCSM), respectively and 160 kg N ha^{-1} gave highest yield without affecting sucrose content. The highest number of tiller (138.70 □ 10^{3} ha^{-1}) was found with 160 kg N ha^{-1} followed by 200 kg N ha^{-1} (132.10 □ 10^{3} ha^{-1}) which was statistically at par with 120 kg N ha^{-1} and 80 kg N ha^{-1} (both were 122.70 □ 10^{3} ha^{-1}). Highest millable cane (68.13 □ 10^{3} ha^{-1}) was found at the rate of 160 kg N ha^{-1} followed by 200 kg N ha^{-1} (67.71 □ 10^{3} ha^{-1}), 120 kg N ha^{-1} (63.75 □ 10^{3} ha^{-1}) and 100 kg N ha^{-1} (61.88 □ 10^{3} ha^{-1}).

Among the varieties, the highest number of tiller was found in variety Isd 32 (155.70 □ 10^{3} ha $^{-1}$), which was followed by the clone I 486-99 (145.90 □ 10^{3} ha^{-1}) (Table 1b). The highest millable cane was obtained from Isd 32 (79.33 □ 10^3 ha^{-1}) which was followed by I 486-99 (73.00 □ 10^3 ha^{-1}). The highest yield was obtained from Isd 32 (51.13 tha^{-1}) and the lowest from I 139-98 (24.40 tha^{-1}). The second highest yield was found in I 486-99 (41.10 tha^{-1}). The highest height was obtained from Isd 32 (2.37 m) followed by I 486-99 (2.35 m) and I 82-98 (2.32 m). The highest diameter was found in I 82-98 (2.28 cm) followed by Isd 32 (2.13 cm). There was a significant interaction effect between nitrogen and variety on yield of sugarcane (Fig.2).

Effect of P on Sugarcane Clones:

Yield and yield attributes

In P experiment the tiller, millable cane stalk, yield, height, diameter and pol percent cane did not show any significant effect with every increment of phosphorus level at High Ganges River Floodplain soils. But among the clones/variety, P application had significant effect on tiller, millable cane, yield and pol percent but it was insignificant for height and diameter (Table 2a). The variety Isd 32 recorded the highest number of tillers (100.30 □ 10^3 ha^{-1}) and millable cane stalk (81.50 □ 10^3 ha^{-1}). The lowest tiller (74.33 □ 10^3 ha^{-1}) and millable cane stalk (59.40 x 10^3 ha^{-1}) were found in I 82-98. The variety Isd 32 recorded the highest yield (65.67 tha^{-1}) followed by I 486-99 (56.46 tha^{-1}). The clones I 486-99 (56.46 tha^{-1}), I 139-98 (48.90 tha^{-1}) and I 82-98 (47.93 tha^{-1}) were found as statistically similar in cane yield. The clone I 139-98 recorded the highest pol percent cane (13.34%) followed by I 82-98 (12.89%) and I 486-99 (12.88 %). The lowest pol percent was found in Isd 32 (11.35%). There was no significant interaction effect of phosphorus and clones/ variety on these parameters.

From the Old Himalayan Piedmont plain soils, it was found that the P application had significant effect on tiller, millable cane, yield, height and diameter but insignificant effect on brix per cent (Table 2b). The variety Isd 32 (156.70 □ 10^3ha^{-1}) recorded the highest number of tillers. The second highest number of tiller was found in I 486-99 (125.30 □ 10^3 ha^{-1}) and the lowest from I 82-98 (82.20 □ 10^3 ha^{-1}). The highest millable cane stalk was recorded in Isd 32 (84.80 □ 10^3 ha^{-1}). The second highest millable canes was recorded in I 486-99 (68.87 □ 10^3 ha^{-1}) and the lowest millable cane stalk was found in I 82-98 (42.83 □ 10^3 ha^{-1}). The variety Isd 32 recorded the highest cane yield (41.60 tha^{-1}). The second highest yield was obtained in I 486-99 (38.80 tha^{-1}) and the lowest yield was from I 139-98 (23.80 tha^{-1}). Highest height was obtained from I 486-99 (2.42 m) followed by Isd 32 (2.32 m) and I 82-98 (2.25 m), respectively and the lowest was from I 139-98 (1.69 m). Highest diameter was obtained from clone I 82-98 (2.19 cm) followed by Isd 32 (2.05 cm). The lowest diameter was found in clone I 139-98 (1.84 cm). There was a significant interaction effect of phosphorus and clones/ variety on yield (Fig. 3).

Effect of K on Sugarcane Clones:

Yield and yield attributes

In K experiment, yield and all yields attributing parameters and pol percent was not differed significantly with the application of potassium fertilizer at High Ganges River Floodplain soils. But among the clones/variety the K application had the significant effect on yield, all yield attributing parameters and pol percent of cane (Table 3a). The variety Isd 32 recorded the highest number of tiller (97.77 □ 10^3 ha^{-1}) and millable cane stalk (80.93 □ 10^3 ha^{-1}). The second highest number of tiller (88.07 □ 10^3 ha^{-1}) and millable cane (72.60 □ 10^3 ha^{-1}) was recorded in I 486-99 that was followed by the clone I 139-98 (81.30 □ 10^3 ha^{-1} and 69.90 □10^3 ha^{-1}, respectively). The lowest number of tiller (68.17 □ 10^3 ha^{-1}) and millable cane

(59.03 □ 10^3 ha^{-1}) was recorded in I 82-98. The highest yield was obtained from Isd 32 (77.19 tha^{-1}). The second highest yield was from I 486-99 (61.64 tha^{-1}). Clone I 139-98 (53.01 tha^{-1}) and I 82-98 (50.70 tha^{-1}) produced identical yield. Highest height of cane was obtained from Isd 32 (3.02 m) followed by I 486-99 (2.94 m). Clone I 139-98 and I 82-98 recorded identical height (both 2.75 m). Highest diameter was found in I 82-98 (2.10 cm) which was followed by Isd 32 (2.07 cm) and I 486-99 (2.01 cm). The lowest diameter was obtained from I 139-98 (1.92 cm) but it was identical with I 486-99. Highest pol per cent was obtained from I 139-98 (12.77 %) which was followed by I 82-98(12.47 %) and I 486-99 (12.34 %). Lowest pol per cent was found in Isd 32 (11.12 %). There was no significant interaction effect of potassium and clones/variety on growth parameters and yield of sugarcane, in pol percent cane (Fig. 4).

From the Old Himalayan Piedmont Plain soils, it was revealed that yield and all the yield attributing parameters except diameter and brix per cent differed significantly with the application of potassium fertilizer (Table 3b). Highest number of tiller (132.20 □ 10^3 ha^{-1}) was obtained from the application of 100 kg K ha^{-1} which was statistically at par with 160 (131.40 □ 10^3 ha^{-1}), 130 (130.10 □ 10^3 ha^{-1}) and 70 (121.60 □10^3 ha^{-1}) kg K ha^{-1}, respectively and the lowest (102.90 □ 10^3 ha^{-1}) was from control. Highest millable cane (67.50 □ 10^3 ha^{-1}) was obtained from 130 kg K ha^{-1} which was at par with the doses of 160 (66.63 □ 10^3 ha^{-1}), 70 (65.88 x 10^3 ha^{-1}) and 100 (63.88 □ 10^3 ha^{-1}) kg K ha^{-1}, respectively. Highest yield was recorded from 160 kg K ha^{-1} (34.96 tha^{-1}) followed by 130 (32.88 tha^{-1}) and 100 (32.25 tha^{-1}) kg K ha^{-1} and the lowest (28.88 tha^{-1}) was from control. Alam *et al*., (1995) stated that in Old Himalayan Piedmont Plain soils of Thakurgaon showed progressive increased in cane yield up to 150 kg K_2O. Application of 160 kg K ha^{-1} produced the highest height (2.40 m) followed by 130 kg K ha^{-1} (2.28 m) and control (2.19 m). Application of 70 and 100 kg K ha^{-1} showed statistically similar height. It was also showed that statistically similar height was found with 130 kg K ha^{-1} and control.

Among the clones/variety, the K application had the significant effect on yield and all yield attributing parameters except brix percent (Table 3b). Highest tiller was obtained from Isd 32 (155.00 □ 10^3 ha^{-1}) and the lowest from I 82-98 (99.87 □ 10^3 ha^{-1}). The second highest tiller was found in I 486-99 (136.10 □ 10^3 ha^{-1}). Clone I 139-98 (103.60 □ 10^3 ha^{-1}) and I 82-98 (99.87 □ 10^3 ha^{-1}) was statistically similar in respect of tiller production. Highest millable cane was obtained from Isd 32 (75.00 □ 10^3 ha^{-1}) followed by I 486-99 (73.00 □ 10^3 ha^{-1}). Clone I 139-98 (56.87 □ 10^3 ha^{-1}) and I 82-98 (50.40 □ 10^3 ha^{-1}) showed statistically similar number of millable cane. Highest yield was obtained from Isd 32 (40.50 tha^{-1}) followed by I 486-99 (37.97 tha^{-1}). Clone I 82-98 (24.27 tha^{-1}) and I 139-98 (24.13 tha^{-1}) was statistically at par in respect of yield. Highest height was found in I 486-99 (2.41 m) followed by Isd 32 (2.31 m). The lowest height was obtained in I 139-98 (1.96 m) which was statistically at par with I 82-98 (2.16 m). Clone I 82-98 showed statistically similar height with Isd 32. Highest diameter was recorded in clone I 82-98 (2.07 cm) and the lowest was from I 139-98 (1.72 cm). There was a significant interaction effect between potassium and clones/ variety on yield of sugarcane (Fig. 5).

From the above discussion, it was found that the clone I 486-99 with 200 kg N, 50 kg P, 60 kg K ha^{-1} at High Ganges River Floodplain (AEZ 11) and 120 kg N, 35 kg P, 100 kg K ha^{-1} at Old Himalayan Piedmont Plain (AEZ 1) soils produced batter yield because of its inherent capability and adaptability in those agro-ecological zones of Bangladesh that was supported by the clone I 202-98 with 150 kg N, 50 kg P and 60 kg K ha^{-1} proved its superiority because of its inherent potentiality and better adaptability in High Ganges River Floodplain soils of Bangladesh (Alam *et. al.*, 2006).

Table 1a. Main effects of nitrogen and variety on yield and yield contributing parameters of sugarcane at High Ganges River Floodplain soils

Variable	**Tiller (□10^3 ha^{-1})**	**Millable cane (□10^3 ha^{-1})**	**Yield (tha^{-1})**	**Height (m)**	**Diameter (cm)**	**Pol (%)**
Nitrogen level (kg ha^{-1})						
0 (N_0)	39.33d	37.38d	23.32d	2.41b	2.02	12.27
100 (N_1)	55.67c	53.71c	36.85c	2.64a	2.14	12.25
150 (N_2)	63.79b	60.75b	41.71bc	2.62a	1.99	12.36
200 (N_3)	68.58ab	64.88ab	47.68ab	2.71a	2.14	12.63
250 (N_4)	72.33a	68.88a	50.89a	2.77a	2.08	12.14
S.E. (±)	1.79	1.80	2.18	0.053	NS	NS
Variety						
Isd 32 (V_1)	69.20a	65.37a	46.15	2.66ab	2.12a	11.42
I 82-98 (V_2)	51.20d	48.03c	34.36	2.53b	2.09a	12.51
I139-98(V_3)	60.67b	58.90b	39.29	2.55b	1.92b	12.80
I486-99(V_4)	58.50c	56.17b	40.57	2.78a	2.16a	12.59
S.E. (±)	0.48	0.87	NS	0.045	0.040	NS

In a column, the figures having same letter do not differ significantly as per LSD at 5% level.

Table 1b. Main effects of nitrogen and variety on yield and yield contributing parameters of sugarcane at Old Himalayan Piedmont plain soils

Variable	**Tiller (□10^3 ha^{-1})**	**Millable cane (□10^3 ha^{-1})**	**Yield (tha^{-1})**	**Height (m)**	**Diameter (cm)**	**Brix (%)**
Nitrogen level (kg ha^{-1})						
0 (N_0)	96.21c	50.83b	28.79c	2.22	2.01	18.41
80 (N_1)	122.70b	61.88a	35.79b	2.19	2.14	18.96
120 (N_2)	122.70b	63.75a	38.75ab	2.30	2.07	18.77
160 (N_3)	138.70a	68.13a	38.50ab	2.39	2.05	18.81
200 (N_4)	132.10ab	67.71a	39.46a	2.33	2.03	18.72
S.E. (±)	3.722	2.946	1.048	NS	NS	NS
Variety						
Isd 32 (V_1)	155.70a	79.33 a	51.13a	2.37a	2.13a	18.15
I 82-98 (V_2)	77.67c	39.33 c	25.80c	2.32a	2.28a	18.73
I139-98(V_3)	110.70b	58.17 b	24.40c	2.11b	1.89b	18.83
I486-99(V_4)	145.90a	73.00 a	41.10b	2.35a	1.94b	19.21
S.E. (±)	4.392	2.361	1.094	0.036	0.040	NS

In a column, the figures having same letter do not differ significantly as per LSD at 5% level.

Table 2a. Main effects of phosphorus and variety on yield and yield contributing parameters of sugarcane at High Ganges River Floodplain soils

Variable	**Tiller (□10^3 ha^{-1})**	**Millable cane (□10^3 ha^{-1})**	**Yield (tha^{-1})**	**Height (m)**	**Diameter (cm)**	**Pol (%)**
Phosphorus level (kg ha^{-1})						
0 (P_0)	80.67	67.71	56.85	2.87	2.12	12.64
30 (P_1)	88.42	69.88	52.88	2.84	2.04	12.74
50 (P_2)	87.96	69.33	54.02	2.89	2.07	12.61
70 (P_3)	87.92	72.25	54.55	2.84	2.08	12.67
90 (P_4)	87.63	72.75	55.39	2.84	2.08	12.42
S.E. (±)	NS	NS	NS	NS	NS	NS
Variety						
Isd 32 (V_1)	100.30a	81.50a	65.67a	2.98	2.13	11.35b
I 82-98 (V_2)	74.33c	59.40c	47.93b	2.74	2.11	12.89a
I139-98(V_3)	83.47bc	69.63b	48.90b	2.79	1.99	13.34a
I486-99(V_4)	87.93b	71.00b	56.46ab	2.92	2.08	12.88a
S.E. (±)	2.83	0.95	3.150	NS	NS	0.304

In a column, the figures having same letter do not differ significantly as per LSD at 5% level.

Table 2b. Main effects of phosphorus and variety on yield and yield contributing parameters of sugarcane at Old Himalayan Piedmont plain soils

Variable	Tiller (□10^3 ha^{-1})	Millable cane (□10^3 ha^{-1})	Yield (tha^{-1})	Height (m)	Diameter (cm)	Brix (%)
Phosphorus level (Kg ha^{-1})						
0 (P_0)	112.33	56.25	27.08	2.22	2.05	18.19
20 (P_1)	116.75	64.58	33.83	2.19	2.01	18.48
35 (P_2)	109.25	61.83	31.71	2.30	1.96	18.63
50 (P_3)	119.83	68.83	33.17	2.39	2.08	18.18
65 (P_4)	121.00	57.67	31.17	2.33	1.98	18.40
SE (±)	NS	NS	NS	NS	NS	NS
Variety						
Isd 32 (V_1)	156.70a	84.80a	41.60a	2.32a	2.05ab	17.83
I 82-98 (V_2)	82.20d	42.83c	27.00c	2.25a	2.19a	18.23
I139-98(V_3)	99.10c	50.47c	23.80d	1.69b	1.84c	18.85
I486-99(V_4)	125.30b	68.87b	38.80b	2.42a	2.00b	18.59
S.E. (±)	2.208	3.321	0.511	0.075	0.046	NS

In a column, the figures having same letter do not differ significantly as per LSD at 5% level.

Table 3a. Main effects of potassium and variety on yield and yield contributing parameters of sugarcane at High Ganges River Floodplain soils

Variable	Tiller (□10^3 ha^{-1})	Millable cane (□10^3 ha^{-1})	Yield (tha^{-1})	Height (m)	Diameter (cm)	Pol (%)
Potassium level (kg ha^{-1})						
0 (K_0)	87.79	69.75	60.24	2.97	2.05	12.36
60 (K_1)	84.38	70.17	62.00	2.89	2.09	12.37
90 (K_2)	80.83	70.83	60.23	2.87	2.01	12.30
120 (K_3)	80.96	70.33	57.52	2.79	1.99	11.94
150 (K_4)	85.17	72.00	63.20	2.80	1.98	11.92
S.E. (±)	NS	NS	NS	NS	NS	NS
Variety						
Isd 32 (V_1)	97.77a	80.93a	77.19a	3.02a	2.07a	11.12b
I 82-98 (V_2)	68.17c	59.03c	50.70c	2.75b	2.10a	12.47a
I 139-98 (V_3)	81.30b	69.90b	53.01c	2.75b	1.92b	12.77a
I 486-99 (V_4)	88.07b	72.60b	61.64b	2.94a	2.01ab	12.34a
S.E. (±)	2.679	1.637	2.301	0.038	0.026	0.307

In a column, the figures having same letter do not differ significantly as per LSD at 5% level.

Table 3b. Main effects of potassium and variety on yield and yield contributing parameters of sugarcane at Old Himalayan Piedmont plain soils

Variable	Tiller (□10^3 ha^{-1})	Millable cane (□10^3 ha^{-1})	Yield (tha^{-1})	Height (m)	Diameter (cm)	Brix (%)
Potassium level (kg ha^{-1})						
0 (K_0)	102.90b	55.21b	28.88b	2.19ab	1.80	19.18
70 (K_1)	121.60a	65.88a	29.63b	2.09b	1.89	19.54
100 (K_2)	132.20a	63.88a	32.25ab	2.08b	1.94	18.38
130 (K_3)	130.10a	67.50a	32.88ab	2.28ab	1.87	19.00
160 (K_4)	131.40a	66.63a	34.96a	2.40a	1.94	19.03
S.E. (±)	5.375	2.075	1.485	0.078	NS	NS
Variety						
Isd 32 (V_1)	155.00a	75.00a	40.50a	2.31ab	1.95b	18.87
I 82-98 (V_2)	99.87c	50.40b	24.27b	2.16bc	2.07a	18.91
I 139-98 (V_3)	103.60c	56.87b	24.13b	1.96c	1.72d	19.09
I 486-99 (V_4)	136.10b	73.00a	37.97a	2.41a	1.81c	19.22
S.E. (±)	1.971	3.066	1.287	0.068	0.022	NS

In a column, the figures having same letter do not differ significantly as per LSD at 5% level.

EFERENCES

1. Alam, F., M.A. Majid and M.M. Uddin. 1995. Effect of potassium on sugarcane production in piedmont plain soils of Bangladesh. Bangladesh J. Sugarcane. 17: 59-65.
2. Alam, K.M., M.A. Haque, S.M. Bokhtiar and G.C Paul. 2006. Effect of nitrogen, phosphorus and potassium on some advanced promising clones/varieties of sugarcane at High Ganges River Floodplain. Bangladesh J. Sugarcane. 28: 76-80.
3. Alexander, D., T. Mathew, B. George, K. Sreekumar, J.M. Kuriakose and G. Jayakumar. 2003. Growth and yield of sugarcane as influenced by genotypes and mineral nutrition. Bharatiya Sugar. 28 (3): 21-25.
4. Bokhtiar, S.M. 2004. Scientific basis and scope of improvement of low sugarcane yield and recoverable sucrose in nutritional aspect of Bangladesh. Pak Sugar J. XIX (I): 27-36.
5. Davidson, L. G. 1962. Nitrogen × variety interaction in sugarcane. Proc. ISSCT, XI Congress Mauritius. pp. 84-87.
6. Humbert, R. P. 1968. The growing of sugarcane. Revised edition. Elsevier Publishing Company, Amstedam. pp. 133-281.
7. Pannu, B.S., Y.P. Dang, L.S. Verma and S. S. Verma. 1985. Effect of phosphorus and potassium on yield and quality of sugarcane. Indian Sugar. 35 (4): 263-265.
8. Raghaviah, C .V. and P. P. Singh. 1980. Yield and nitrogen uptake of sugarcane varieties at graded levels of N. Indian Sugar. 29 (1): 13-17.
9. Rahman, M.H., M.K.A. Chowdhury, M. Khondakar, S.K. Pal and M.Y. Ali. 1993. Effect of nitrogen on spaced transplanted sugarcane. Bangladesh J. S.cane. 12-15: 45-48.
10. Rahman, M.H., M. Khondakar, S.K. Pal, M.A. Majid, M.W. Zaman and F. Alam. 1989. Effect of nitrogen on growth, yield and sucrose content of sugarcane. Bangladesh J. Sugarcane. 11: 83-86.
11. Tabayoyong, F. T. and M. Robeniol. 1962. Yield response of sugarcane to fertilizer. Proc. ISSCT.XI Congress, Mauritius. pp. 177-185.
12. Trivedi, N. and S. K. Saini. 1986. Response of sugarcane varieties on N application under Taral condition of Uttar Pradesh. Indian Sugar. 35 (11): 606-607.

SCREENING OF FINAL SUGARCANE GENOTYPES (*Saccharum officinarum L.*) FOR RED ROT *Colletotricum falcatum* Went DISEASE RESISTANCE

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ABSTRACT

Thirty sugarcane (*Saccharum officinarum)* genotypes were screened two consecutive years 2007-2008 against red rot (*Colletotricum falcatum*) disease by artificial inoculation using "syringe method". The genotypes were graded as various levels of susceptibility and resistance using standard disease index. Two genotypes S98CSSG-668 and S98CSSG676 appeared resistance, one moderately resistance, two moderately susceptible and twenty five were susceptible. These genotypes (S98CSSG-668 and S98CSSG676) may be utilized as one of the sources of resistance on the breeding programme of sugarcane to red rot disease.

Key words: Sugarcane genotypes, red rot, *Saccharum officinarum*, disease resistance

INTRODUCTION

Sugarcane is a renewable, natural agricultural resource because it provides sugar, besides biofuel, fiber, fertilizer and myriad of by products/co-products with ecological sustainability. Sugarcane provides over 50% of the worlds sugar requirements as it can grow in any country where it is not exposed to frost. Worldwide sugarcane occupies an area of 20.42 million ha with a total production of 1333 million metric tons. Sugarcane area and productivity differ widely from country to country. Sugarcane growing countries of the world are lying between the latitude 36.7° north and 31.0° south of the equator extending from tropical to subtropical zones.

Sugarcane is also the second most important cash crop in Pakistan after cotton. Pakistan grows about 1 million hectares of sugarcane, more than all other cane producing countries contributing around 3.6% of Gross Domestic Production (GDP) (Anon. 2005). Pakistan's sugarcane yield averages about 46 tonnes per hectare, well below the world average of above 60 tonnes, and below neighboring India's yield of 65 to 70 tonnes. Sugarcane currently accounts 4.8% of cropped area and 11% value added of the total crops (Anon.2005).

Red rot is one of the oldest known diseases of sugarcane. It occurs in most cane-growing countries. Red rot disease of sugarcane is one the main limiting factors in cane yield and quality. (Chona, 1980 and Martin, 1961). It is caused by a fungus ***Collectotrichum*** *falcatum* which is carried year after year by infected setts, debris and it spores which remains lying in fields after the harvest of infected crop. This disease causes heavy loss to the sugar industry as well as the growers. Red rot appears in July and continues to develop till harvesting of the crop. In the initial stages, loss of colour and withering of leaves, third and fourth from the top, is seen. In the later stages, the stalk becomes dry, wrinkled and hollow. Typical symptoms of red rot are seen inside the stalk. If stalks are split open, the pith is found reddened. The diseased tissues of the stalk emit alcoholic smell as a result of inversion caused by the pathogen. The disease is responsible for quick decline of varieties.

Development of new pathotypes in the RR flora of Tamil Nadu, the commercial varieties viz: COC-671, COC-85061, CoC-86062, CoSi-86071, CoC90063, CoC-91061, CoC-92061, CoSi-96071and CoSi-98071 have become susceptible to red rot (Kalaimani, 2000). In Pakistan a good number of commercial verities e.g. CoL-54, CoL-29, L-116, Triton, BL-4 and BF-162 are susceptible to red rot. The old verities are out from the field due to one or another reason. The use of resistant/moderately resistant verities is the cheapest practical method of disease control to avoid any epidemics. Development of new varieties is the needs of the time to give boost a sugar industry in Pakistan. (Hussnain *et. al.*, 2007)

MATERIALS AND MATHODS

Thirty sugarcane genotypes were evaluated at Shakarganj Sugarcane Research Institute (SSRI), Jhang, (Pakistan) during the years 2004-2007. Plantation was done in randomized complete block design (RCBD) in two rows of 5 m length. Syringe artificial methods were used for inoculation according to method describe by Hussnain and Afghan 2001. For preparation of inoculum, a pathogenic culture of *Colletotrichum falcatum* isolated from susceptible sugarcane variety Co-1148 on potato dextrose agar medium in petri dishes. Petriplates were incubated at 28 $\pm 1^0$C for 10 to 15 days. The culture grown on petri dishes was harvested in sterilized water at the rate of one plate per liter (approximately 10^6 spore per ml) and suspension was used for artificial inoculations. Twenty-five canes were taken in each genotype for inoculation and means of the canes was used for data. Inoculation was done in the month of July, when cane attained the age of 7th month. A hole was made with 20ml hypodermic needle having 16-G size on the 3rd exposed internode from bottom. Spore suspension at a concentration of 10^6 ml^{-1} was added with the same needle. The hole was then covered with moist clay to ensure optimum moisture after inoculation inside the hole. Disease severity observed after 60 days on the basis of the international scale (0 to 9) as suggested by Srinivasan and Bhat (1961).

Scale	**Score**
0.0-2.0	Resistance (R)
2.1-4.0	Moderately resistance (MR)
4.1-6.0	Moderately susceptible (MS)
6.1-8.0	Susceptible (S)
8.1-9.0	Highly susceptible (HS)

RESULTS AND DISCUSSION

The disease reaction of all the thirty genotypes was given the table-1. Out of thirty genotypes, only two S98CSSG-668 and S98CSSG676 depicted resistant reaction (0.0-2.0). One genotype S98CSSG-562 showed moderately resistant reaction (2.1-4.0). Two genotypes showed moderately susceptible (4.1-6.0) reaction viz. S98CSSG-663 and S98CSSG-554 and remaining twenty five were susceptible to red rot as per method testing.

Table-1 Reaction of sugarcane genotypes against red rot

Pathogenicity reaction	Sugarcane genotypes
0.0-2.0 (Resistance)	S98CSSG-668 S98CSSG676
2.1-4.0 (Moderately resistance)	S98CSSG-562
4.1-6.0 (Moderately susceptible)	S98CSSG663 & 554
6.1-8.0 (Susceptible)	S98CSSG-209, 392, 494, 523, 567, 579, 582, 612, 614, 671, 691, 706, 712, 717, 718, 94, 1199, 1448, 1718, 1731, 1742, 1744, 1791, 1914 & 2175.
8.1-9.0 (Highly susceptible)	Nil

REFERENCES

1. Anonymous. 2005. Economic survey on crop situation. Federal Bureau of Statistics. Government of Pakistan. Islamabad: 10.
2. Anonymous. 2005. Sugar and sugarcane saistics. Annual report, PSMA: 63-64.
3. Chona, B. L. 1980. Red rot of sugarcane and sugarindustry-a review. Indian Phytopath., 33:191-206.
4. Hussnain, Z. and S. Afghan. 2001. A comparative study on artificial inoculation methods for Red rot. *Colletotrichum falcatum* (Went) screening. Pakistan Sugar J. 16 (2): 03-05
5. Hussnain, Z., S. Afghan, K. Hussain, A. Naheed, S. Rizwana, and P.Khanum, 2007. Screening of promising sugarcane genotypes (*S. officinarum*) against red rot (*C. falcatum* Wen) through syringe method of inoculation. Indian Sugar J.: 23-26
6. Kalaimani, T. 2000. Screening of sugarcane varieties/clones against red rot disease. Indian Sugar. 50 (2): 97-98.
7. Martin, J.P., E.V. Abbot, and C.G. Hughees. 1961. Sugarcane diseases of the World. Vol.1 Elsevier Pub. Co., Amsterdam, P. 642.
8. Srinivasan, K. V. and N.R. Bhat.1961. Red rot sugarcane criteria for grading resistance. J. Indian. Bot. Sci. 11: 565-577.

SUGAR INDUSTRY ABSTRACTS

M. Awais Qureshi and Shahid Afghan

AGRICULTURAL ENGINEERING

Optimised agricultural planning of sugarcane using linear programming
M.S. Scarpari, M.G.A. Landell and E.G.F. de Beauclair

Optimised agricultural planning is a fundamental activity in enterprise profitability because it can increase the returns from an operation with low additional costs. Nonetheless, the use of operational research adapted to sugarcane plantation management is still limited, resulting in decision-making at management level being primarily empirical. The goal of this work was to develop an optimised planning model for sugarcane farming using a linear programming tool. The programming language used was General Algebraic Modeling System (GAMS) as this system was seen to be an excellent tool to allow maximisation of profit and optimisation of the harvesting time schedule in the sugar mill studied. The results presented support this optimised planning model as being a very useful tool for sugarcane management.

AGRICULTURAL AGRONOMY

Dual row planting. a system to increase Thai farmers cane yield and economic returns
T. Klomsa-ARD, C. Prasantree, S. Jomsri, A. Tenglolai, P. Prammanee and P. Weerathaworn

The purpose of this paper is to evaluate the effect of the planting system to increase sugarcane yield and economic return on growers. farms. Trials to evaluate the dual row planting system were conducted on various sugarcane farms under rainfed conditions in four locations belonging to cane growers. The trials were conducted under rainfed conditions in the Khon Kaen and Chaiyaphum districts of Northeast Thailand. Two planting methods (110.50 cm double row and 100 cm single row) were compared using two varieties (K84-200, poor tillering and K88-92, good tillering). The experimental design was a randomised complete block with four replications, and the work was conducted over the 2003.2006 period. The results showed that dual row planting increased cane yield by 18.53 percent compared with single row planting. The increase in cane yield was found to be significantly correlated with the number of millable stalks. Cane juice quality was not affected by the different planting methods. An economic analysis showed that profits could be increased from 177.629 $/ha due to dual row planting. Based on these results, dual row planting offers the opportunity to increase productivity, and is a profitable farming system suited to Thai growers and the Thai sugar industry.

Systems to balance production and environmental goals of nitrogen fertiliser management
P.J. Thorburn, A.J. Webster, I. M. Biggs, J.S. Biggs, S.P. Staunton and S.E. Park

Replacement of nitrogen from crop off-take and environmental losses has been suggested as a sustainable system of nitrogen management for sugarcane production. Since 2003, we have initiated 12 on-farm field experiments to test the ‘N replacement’ concept in the range of environments spanned by the Australian industry. In conjunction with field trials, we also increased efforts on monitoring N stress in cane using Near Infra Red Reflectance instruments (NIR) located at sugar mills. Field results so far are encouraging, with little average difference (0.3 t/ha) in yield between replacement and conventional N treatments. Soil N does not appear to have been ‘mined’ with reduced N fertilizer application. Profitability has been marginally increased while risks of N losses to the environment, estimated from N balances at the sites, are considerably lower in the N replacement treatments. Good NIR calibrations have been obtained for predicting sugarcane N concentration. Using these, mill-monitored stem N compared well with field measurements at two sites. Where there are needs to improve profitability and reduce environmental impacts of sugarcane production, the N replacement concept may be worth investigation.

SUGARCANE BREEDING

Starch content in different cane cultivars and trash

R. Muangmontri, U. Pliansinchai and P. Weerathaworn

The starch content in sugarcane is an important quality factor in sugar processing and affects the juice viscosity and slows crystallisation. This study aimed to identify sources and content of starch in cane: 1) In different commercial cane cultivars, using cuttings of 9 to 14 months. 2) In trash of different cultivars using top at natural breaking point), leaf sheath, stalk (without trash). 3) In different parts of cane stalk (top, middle, and bottom). 4) Different cutting sizes (long top cut, natural breaking point cut and two internodes below breaking point cut). Results showed that: 1) Starch contents varied among cultivars. 2) In trash, starch content in tops was higher (335–642 ppm) than in lower stalk tissue (152–223 ppm). 3) Starch content was higher in stalk tops (972 and 2646 ppm) and lower in bottoms (457 and 1254 ppm). 4) The lowest content obtained from cutting method (two internodes below breaking point), both in high starch content cultivar, K84-200 (1683 ppm) and low starch content cultivar, LF82-2122 (308 ppm). These results suggest possibilities to reduce starch content by using low starch content cultivars, reduce trash, and improve cutting methods.

SUGARCANE PATHOLOGY

Effects of sugarcane yellow leaf virus infection on sugarcane yield and root system development

A.C.M. Vasconcelos, M.C. Gonçalves, L.R. Pinto, M.G.A. Landell and D. Perecin

Sugarcane yellow leaf disease causes significant yield losses in susceptible sugarcane varieties. In Brazil, YLS was not recognized as an economically important disease until the early 1990s when the drastic epidemics of the disease occurred in variety SP71-6163. Since then, breeders began to take into account its occurrence during the selection stages and its effects on vegetative development. The objective of the present work was to evaluate the effects of the *Sugarcane yellow leaf virus* (SCYLV), the causal agent of yellow leaf on sugarcane yield and root system development. The experiment was conducted in Ribeirão Preto, SP, Brazil, on Typic Hapludox soil, in variety IAC89-2135 during the plant cane cycle. SCYLV diagnosis was assayed by DAS-ELISA and RTPCR for discrimination between infected and uninfected plants. The infected plants showed significant reduction of root dry weight and fresh weight of the above ground plant parts and an increase in Brix and sucrose content in the stalks. Although infected plants maintained the root system vertical architecture, root dry weight was reduced and negatively correlated with fresh weight and stalk number, showing that alterations in root and vascular systems may constitute important effects caused by SCYLV infection.

FACTORY ENGINEERING

The conversion of a Bma diffuser to a bosch projects chainless diffuser. the first seasons experience

K.E. Schröder, I. Voigt and B.St.C. Moor

During 2005, the UCL sugar factory was faced with the prospect of major costs on their BMA diffuser, including a chain replacement, drive repairs and the possible prohibitive cost of future capacity expansion. Bosch Projects introduced UCL to the concept of the chainless diff user, and a study showed that their BMA diffuser could be converted to the chainless design at a lower cost than the alternative maintenance costs. The conversion would also allow for cost-effective future expansions. A pilot plant was designed and installed at the UCL factory to test the chainless diffuser concept and to gather data for the conversion of the BMA diffuser. After successful trials, the design for the conversion of the BMA diffuser was carried out by Bosch Projects and the conversion performed in January and February 2006, with the milling season starting late in February. Performance results since commissioning are reported and compared with the diffuser performance prior to the conversion. Maintenance experience and costs are reported. Because this was the first installation of a novel design, compromises were made to allow for re-instatement of the old diffuser had this been necessary. In particular, the old perforated floor was initially retained, with the new chainless deck installed above it. This created a chamber in which fibrous deposits accumulated, causing blockages and sucrose destruction. At the time of writing, the chainless diffuser has been in operation for 9 months, achieving comparable throughput performance despite the reduced bed height. The extraction performance is a little less than that of the BMA diffuser at this time. This is explained by the initial compromises. Teething problems and design shortcomings have been identified. Some of these have been corrected while the rest will be addressed during the 2006.07 off-crop. This paper reviews the patented chainless diffuser concept, describes the pilot plant and the conversion of the BMA diffuser to a Bosch Projects Chainless Diffuser, and the operational and maintenance performance since commissioning.

The detection of sugar traces in the tongaat hulett refinery condensates by nir spectroscopy

G.R.E. Lionnet, M. M. Mavuso, N. Oosthuizen, P.F. Nieuwoudt and D. Searl

The presence of sucrose in condensates used as boiler feed water in raw sugar factories can be detected using conductivity since cane juice contains enough inorganic species to measurably change the conductivity of the condensate; this approach is not possible at the Tongaat Hulett Refinery because of the high purity of the liquors. This refinery uses a total organic carbon analyser; it oxidises soluble organic matter in the condensate to carbon dioxide that is then detected quantitatively and converted by stoichiometry to sucrose concentrations. Chemicals are needed for the oxidation and the time required for the reactions is about three minutes for a sample, requiring large volumes of condensates to be held in tanks. A FT-NIR spectrometer with a probe for liquids was investigated as an alternative, since it does not require chemicals and has a sample processing time of about 30 seconds; calibrations are required but this can now be in terms of sucrose concentration. The spectrometer was run in parallel with the total organic carbon analyser for a period of four months. Installation, commissioning and day-to-day operations were simple and problem free; maintenance was minimal. Calibrations, using the phenol-sulfuric acid method for sugar traces, were done regularly. The results obtained show that the equipment and technique are robust and easy to operate; calibrations are essential but this is the case with most sugar trace detection methods. Accuracy in NIR systems depends essentially on the quality of the calibrations; the NIR instrument could report sugar traces at concentrations of 10 and 20 mg/L, as required by this application, within acceptable limits. Variations in sample temperature were found to impact on the accuracy but this effect can be eliminated.

FACTORY PROCESSING

On line devices for process monitoring and control of sugar production—the purity analyser

Mathis Kuchejda and Sükrü Yilmaz

The Development was made to acquire reliable process data close to the process flow in order to directly control the process parameters based on the more frequent analysis of the factory juices. Due to the automation, manual laboratory work is reduced, resulting in higher staff efficiency and a higher consistency of the data. Data were obtained comparing the manual laboratory results to the automatically produced results. Deviations between the methods and the sample preparation are discussed and methods developed to produce consistency between the lab results and the on-line data. Information of trends in the factory process is presented. The immediate benefit is the reduction in resources, additives and environmental damage.

Adsorbents for sugarcane juice clarification: an innovative technology

R. Condemarin

The need for a SO_2-free sugar, the troublesome and polluting sulfitation step and the wish to achieve a direct white sugar are key interests in the sugar industry. Special adsorbents can be used as a substitute for the traditional sulfitation clarification process, as well as an improver of the raw sugar colour which is used as raw material in the refined sugar process. The use of adsorbents for sugarcane juice clarification involves an innovative process which enables the removal of colour compounds from the sugarcane juice, showing high efficiency in the purification process. Several laboratory tests, developed in Peru and Cuba, confirmed the application opportunity for specially formulated adsorbents to obtain a clarified sugarcane juice. A first Pilot Plant trial implemented at the sugar institute in Las Villas University in Cuba obtained positive results. Encouraged by this, a set of industrial trials was conducted in sugar mills in several countries. By using special adsorbents, an appreciable colour decrease in clarified juice, syrup and melted raw sugar can be obtained. In white sugar with different qualities, special adsorbents eliminate any hazardous residuals in the final sugar.

MANAGEMENT

A report on the first ISSCT management workshop, July 2006

A.T. Wynne and R. Rivalland

The executive and Council of the International Society of Sugar Cane Technologists (ISSCT), prior to the XXV Jubilee Congress in Guatemala 2005, set up a 'Management Commission'. Its intention was to enlarge the role of senior industry managers in the ISSCT, with particular reference to integrating management aspects into research and technological initiatives with a view to further enhance overall efficiencies. The first ISSCT Management Workshop was held in Durban, South Africa in July, 2006 and was attended by 41 delegates from 10 countries. The workshop objectives were to (1) attract delegates from wide ranging fields of expertise to provide specialist inputs, and (2) facilitate discussion focused on improving efficiencies and sustainability. Each of the four workshop sessions comprised three presentations that were intended to initiate discussion on a particular theme, enabling delegates to interactively participate in defining their contextual problems and to jointly take part in finding solutions. The respective themes were (1) managing research and development, (2) managing the supply chain, (3) the role of sugarcane in 2020 and (4) market demands and dynamics. One of the challenges for future workshops will be how to attract managers into the forum. In this regard senior managers from the various research organisations and other sugar industry related organisations should be targeted. Some of the main topics recommended for future workshops include the management of (1) technology transfer, (2) environmental impacts, (3) water scarcity, (4) the implementation of GMOs, (5) health, safety and human resource related issues, (6) benchmarking the costs of production, (7) integrating industry and research strategies, (8) optimising the mix between managers, researchers and technicians, (9) the incorporation of bio-energy production into sugar industries, and (10) international cooperative research initiatives.

Setting up of a greenfield sugar project in Africa: a practical approach
Vivek Bhardwaj, E.Y. Alloo and I.Y. Alloo

Zambia is a landlocked country with plenty of unutilised land, abundant availability of surface water and favourable agro-climatic conditions for sugarcane cultivation. Increasing sugar demand in the region and lucrative policies of the Government of Zambia provided an incentive for the setting up of a greenfield sugar project. Looking at the market conditions, a sugar plant to produce plantation white sugar with provision to produce off-white sugar, along with a facility for Vitamin-A fortification was chosen. Lack of appropriate infrastructure and shortage of trained manpower in Zambia were two of the challenges that were tackled successfully by using solutions that were appropriate and practical.

COPRODUCTS

By-products from bagasse
D.F Day, G. Dequeiroz, C-H. Chung and M. Kim

A biorefinery will have to produce a range of products, including ethanol, for economic viability. Any process for manufacturing ethanol from bagasse will also yield lignin fragments which contain aromatic compounds, and some cellobiose due to incomplete cellulose conversion. The pretreatment and hydrolysis methods dictate the actual compositions of these streams. An ethanol, organo-solv process, a singlet oxygen pretreatment and an ammonia explosion process were tested, not only for their ability to increase sugar availability for fermentation, but also for the ‘by-products’ produced. A range of monophenolic compounds derived from the lignin were detected, ranging from 30 mg to 100 mg of vanillin equivalent per gram of dry bagasse. The mono phenols produced by the various treatments were characterised using GC/MS. The compound with commercial value that turned up in all treatments was vanillin. Typically, enzyme hydrolysis of ligno-cellulose produces primarily glucose and a small amount of cellobiose. Cellobiose in its own right is a potentially valuable product as a nonnutritive sugar. Co-production of a □-glucosidase inhibitor, gluconic acid, during enzymatic hydrolysis of cellulose altered the amounts of glucose and cellobiose produced. Addition of a □-glucosidase inhibitor, gluconolactone or gluconic acid, significantly increased the amount of cellobiose with a corresponding decrease in amount of glucose produced. In situ production of cellobiose during enzymatic conversion, using the enzyme glucose oxidase, yielded the same effect. With a suitable concentration of glucose oxidase it was possible to convert over 19.3% of the cellulose to cellobiose.

New sugarcane varieties and year round sugar and ethanol production with bagasse-based cogeneration in Barbados and Guyana

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The sugar industries of Barbados and Guyana have been looking for ways to secure their industries in view of the increasingly uncertain sugar markets and a likely price reduction for export sugar. These industries have therefore been exploring opportunities to generate additional income from energy through the production of ethanol and electricity. New multipurpose cane (MPC) varieties with very high fibre content developed at the West Indies Central Sugar Cane Breeding Station (WICSCBS) in Barbados have been found to produce more biomass per hectare and a wider range of brix values when compared to the traditional sugar cane varieties. The MPC varieties are being tested and would be likely to complement older commercial varieties in the traditional crop period as well as during the out-of-crop season to supplement bagasse production for co-generation projects. These varieties are also being considered for the production of ethanol. In Barbados, the feasibility of a 12 month operation to produce electrical power as the principal product, with direct consumption raw sugar, molasses and fuel as co-products has been evaluated. Conventional sugarcane varieties would be grown on 40% of the present cane lands and MPC varieties on the rest of the estates. This project is anticipated to commence with the completion of a new multi-purpose production facility in 2009. In Guyana, the construction of a 8400 tonne cane per day (TCD) mill has commenced. This mill will supply 10 megawatts (MW) of power to the grid by co-generated electricity. A 12 million litres fuel alcohol distillery is likely to be attached to this factory. High fibre MPC varieties with acceptable levels of fermentable sugars are under evaluation for extending the supply of bagasse and contributing to fuel ethanol production in an extended crop season.