PAKISTAN SUGAR JOURNAL

January-February 2006
VOLUME XXI, NUMBER 01

SUBSCRIPTION RATE

PAKISTAN

PSST Members/Sugar Companies/Other Rs.300/-

OVERSEAS US$25/-

Subscription rates include 6 issues for Pakistan Sugar Journal, airmail delivery

ISSN 1028-1193

Subscription and Advertisement Service

Mohammad Awais Qureshi

Shakarganj Mills Ltd.,
Toba Tek Singh Road, JHANG
Tel: 0471-629337-41
Telex: 43471 CJP PK.
Fax: 0471–620272, 613050
E-mail: shahid@shakarganj.com.pk

Published by

Mohammad Asghar Qureshi

Under the patronage of
SHAKARGANJ
SUGAR RESEARCH INSTITUTE

ARTICLES **PAGE #**

EVALUATION OF GROWTH AND YIELD PARAMETERS OF DIFFERENT SUGARCANE (*SACCHARUM OFFICINARUM* L.) VARIETIES UNDER NATIONAL UNIFORM VARIETAL TRIAL ON

By

A. N. Naich, P. A. Baloch and B. A. Abro
Quaid-e-Awarn Agricultural Research Institute, Larkana

ABSTRACT

A field experiment was conducted under National Uniform Varietal Yield trial on different sugarcane varieties to compare their performances against L-116 variety at the experimental field of Quaid-e-Awam Agricultural Research Institute, Larkana during the year 2002-03. The results revealed differences among yield and growth characters. The varieties LRK-2001 and M-17 proved good response of environmental reaction for Brix (%) and cane yield. Their inclusion as approved variety is recommended for general cultivation in upper Sindh province.

Keywords: Sugarcane, National Uniform Varietal Trial, Girth, Brix %, Cane yield.

INTRODUCTION

Sugarcane (*Saccharum officinarum*, L) is one of the most Important cash crops of Pakistan. It occupies a significant position in the economy of our country on account of various industrial products and satisfies human and cattle need (Panhwar, *et al.*, 2003). Besides, food and feed, it also provides a huge amount to the national exchequer in the form of excise duty (Rehman *et al.*, 1992). The production per unit area of sugarcane in our country is considerably lower (473 t) than may other sugarcane producing countries of the world (Panhwar, *et al.*, 2003). The main reasons for the low yield of sugarcane in our country are infertile soils (low organic matter), irrigation constraints, traditional farming system, climatic hazards and non-availability of promising varieties.

Agricultural breeders are evolving high yielding sugarcane varieties since last many years, but it has been noted that varieties evolved for one climatic zone of the country fails to produce same production in other zones of the country. According to Khan (1981) plant growth is the main factor that allows the varieties to adopt themselves to varying environmental conditions and compensate for loss of yield. Certain varieties have a large range- of adaptability than other and hence are grow more widely throughout the area due to more productivity stability (Glaz, 1982).

For obtaining above mentioned goals a research program for the development of sugarcane varieties was started on cooperative basis among three provinces of the country. During this program exchange of approved promising varieties was made to compare the quantitative and qualitative performance of different sugarcane varieties with three replications having net plot size of 8x4 ($32m^2$). The detail of the varieties studied is as follows.
LRK-2001, BF-138, S96SP-302, S95HS-185, Q-88, CPH-35, M-116, NSG-311, S84-1-282, M-17, S86VS-340, L-116 (CHECK)

The ridges/furrows were made at the distance of 100cm. The seed sets were placed at depth of 6-8 inches, covered with soil and irrigated. The sowing was completed in the month of October, 2002. The NPK fertilizers and other agronomic practices were carried out uniformly as per recommendations. The observation on germination (%), cane length (cm) cane girth (cm), tillers /stool, brix (%) and yield tonnes ha^{-1} were recorded on monthly basis and at the time of harvest from each variety. The data thus collected were subjected to analysis of variance to discriminate the superiority of treatment mean, LSD test was applied following Gomez and Gomez (1984).

RESUL TS AND DISCUSSION

Germination Percentage (%)

The results for germination percentage (%) (Table) exhibit that local variety LRK-2001 produced higher germination percentage (65.00) followed by varieties Q-88, NSG-311, L-ll6 check) and S86US-340 having 62:00, 61.00, 61.05 and 61.00% mean germination percentage respectively. However, the minimum germination percentage (59.00%) was recorded for the variety S96SP-302. The higher germination percentage might be the genetic characteristics of the parent materials of these varieties as also reported by (Baloch, et aI, 2004 and Rehman, et aI, 1991).

Cane length (cm)

The results regarding cane length (cm) reveals that highest cane length (35.0) was recorded in case of variety S95HS-185 followed by NSG-311, LRK-2001, S84-l-282, Q-88 and M-116 with 34.0, 33.0, 31.0 and 31.0cm respectively. While, the minimum cane length (23.0cm) was recorded in case of variety BF-138. This higher cane length in S95HS-185 followed by NSG-311 and LRK-2001 might be due to the genetic make up of the parent materials of these varieties. These results partially supported by the findings of Baloch, (2004) Dey, et aI, (1994) who reported different response of yield component in different sugarcane cultivars.

Cane girth (cm)

Stalk diameter is an important yield contributing trait and use of large stalk diameter would enhance the acceptability of varieties from commercial point of view (Ramdoyal, 1999). The results regarding cane girth (cm) revealed that the variety S95HS-185 produced significantly more cane girth (3.60 cm) followed by LRK-2001 with average cane girth of 3.40cm.

Number of tillers stoo1

The results regarding number of tillers stool (Table-1) revealed that variety LRK2001 produced significantly maximum number of tillers (14.00) stool, followed by variety NSG-311 with 12.66 average number of tillers stool. Varieties S96SP-302 and S84-I-282 also produced good number of tillers 10.00 and 10.00 stoo1 respectively. While, the minimum number of tillers stool (7.00) were recorded in case of varieties BF-138 and S86VS-340. The higher values for number of tillers stoor1 obtained in case of variety LRK-2001 might have genetically associated to have greater tillering capacity. These results are further supported by the findings of Saxena, et aI, (1996) and Das, et aI, (1996) who studied considerable number of sugarcane varieties and found significantly varying trend of effectiveness in all varieties, regarding number of tillers stool.

Brix (%)

Field brix is a good estimation of the sugar content in sugarcane (Ramdoyal, J 999) and is used as a criterion for evaluation of maturity and quality of sugarcane under field condition (Habib, *et al.*, 1992). The results of Table1 revealed that variety S95HS185 had high brix percentage 22.02 closely followed by varieties S86US-340, with 21.02 and 21.00 for each LRK-2001, S84-I-282 and L-116 (check). Likewise, the lowest brix percentage (18.00%) was recorded in varieties BF-138 and M-116. This higher brix % in varieties S95HS-185, LRK-2001, S84-I-282 and L-116 (check) was mainly associated with the genetic makeup of the parent material of these varieties. These results are in agreement with the findings of Singh, et aI, (1994), Saxena, et aI, (1996), Panhwar, et aI, (2003) and Baloch, et aI, (2004) who studied a number of sugarcane varieties and found different levels of brix %.

Cane yield (t ha^{-1})

The results (Table1) revealed that variety LRK-2001 produced average cane yield of 193.33 tonnes ha^{-1} followed by M-17, which produced cane yield of 168.88 tonnes ha^{-1}. Variety S96SP-302 also produced good results with cane yield of 161.11 tonnes ha^{-1}, while S95HS-185 and CPH-35 varieties had cane yield of 156.66 and 155.55 tonnes ha^{-1}, respectively. The lowest cane yield of 81.11 tonnes ha^{-1} was produced by variety L-116 (check). This higher cane yield per hectare of variety LRK-2001 was mainly associated with higher germination percentage, more number of tillers stool and better values regarding cane length, cane girth and brix (%). The results are in agreement with those of Singh, et aI, (1994), Das, et aI, (1996), Singh and Singh (2000) and Baloch, et aI, (2004) who carried out a number of studies on different sugarcane varieties and found different trend for cane yield per unit area.

The experiment elucidated the best environmental reaction of LRK-2001 in respect of germination percentage (%), cane length (cm), cane girth (cm), tillers stoor1 and yield (t ha^{-1}) and hence its cultivation in this area is recommended.

Table-1 Different yield and growth parameters of various sugarcane varieties as recorded under agro-ecological conditions of Larkana, Sindh

Varieties	Germination %	Cane length (cm)	Cane girth (cm)	Tillers/ plant	Brix %	Yield (t ha^{-1})
LRK-2001	65.00	33.0	3.40	14.00	21.00	193.33
BF-138	54.00	23.0	2.40	7.00	18.00	68.88
S96SP-302	59.00	27.5	3.60	10.00	19.00	161.11
S95HS-185	60.00	35.0	3.00	12.00	22.02	156.66
Q-88	62.00	31.0	2.85	8.00	19.02	150.00
CPH-35	58.00	28.0	3.00	8.00	19.00	155.55
M-116	56.00	31.0	2.80	9.33	18.00	140.00
NSG-311	61.00	34.0	2.95	12.66	20.00	154.44
S84-1-282	59.05	33.0	2.70	10.00	21.00	13 7.77
M-17	58.00	30.0	3.20	8.00	19.00	168.88
S86US-340	61.00	29.0	3.00	7.00	21.02	135.55
L-116 (check)	61.05	27.5	2.20	8.00	21.00	81.11
SE	0.652	0.053	0.046	0.402	0.244	1.361
LSD 0.05	1.965	0.140	0.113	1.559	-	6.118
LSD 0.01	2.713	0.185	0.130	1.902	-	8.036

REFERENCES

1. Baloch, F. M, N. A. Soomro, S. A. Ali, T. J. A. Buriro and M.U.Usmanikhai1.2004. Comparison of quantitative and qualitative parameters of local sugarcane varieties with varieties of other provinces. Indus Journal of Plant Sciences, 3(3): 303-307.

2. Das, P. K, B. C. Jena, N. Nayak and A. K. Parida 1996. Correlation and path analysis of cane yield is sugarcane. Cooperative sugar. 27(7): 509-512.

3. Dey, P. C., P. K. Goswami and S.N.Singh 1994. COBLN 9103. An efficient sugarcane variety for water logged conditions of Assam. Indian-Sugar, 44(7): 521-522.

4. Glaz, B.1982. Sugarcane variety census. Sugar Y. Azucar. 46(12): 37-38,40.

5. J. J, mez, K. A and Gomez. 1984. Statics for Agricultural Research (2nd ed). John Willey and Sons. New York. pp. 180.

6. Habib, G., Malik, K.B. and M.Q. Charta. 1992. Preliminary evaluation of exotic sugarcane varieties for qualitative characteristics. Pak. J. Agric. 13 (4): 320-326.

7. Khan, A. Q. 1981. Varietal buffering in sugarcane. Indian sugar, 31, 409-411. (ISJ, 85(1010)-50. 1983).

8. Panhwar, RN., H. K. Keerio, Y. M. Memon, S. Junejo. M. Y. Arian, M. Chohan, A. R Keerio and B. A. Abro, 2003. "Response of Thatta-l0 Sugarcane. variety to Soil and foliar application of Zinc Sulphate (ZnS04. 7H2O) Under half and full doses of NPK fertilizer:. Pak. J. Applied Sci., 3 (4): 266-269, 2003.

9. Ramdoyal, K.1999. Genetic correlation and repeatability of agronomic characters in sugarcane population in contrasting environment and different crop years. Sugarcane. No.4. pp 6-12.

10. Rehman, S., G. Khan and Khair, 1992. "Coordinated uniform national varietal trail on Sugarcane" Pakistan. J. Agric. Res. 13(2): 136-140, 1992.

11. Rehman, S., G. S. Khan, M. Ali and I. Khan 1991. Screening of sugarcane varieties for drought resistance, yield and quality characters. Sarhad. J of Agric. 7(1): 59-64.

12. Saxena, M. M. S., P. S. Verma, B.D. Singh and G.P. Singh. 1996. COS 93218-9 mid late maturing variety for O.V.P. Bharatiya - Sugar, 22(3): 33,35-36.

13. Singh, B. S. Singh and RPal.1994. Direct and indirect effects of characters affecting cane yield of five sugarcane crosses. Crop Research Hisar. 8(2): 302-304.

14. Singh, RK and D.N.Singh.200. Evaluation of early sugarcane varieties for sustaining high sugar recovery in Ittar Paradesh. Cooperative sugar., 31 (1 0):797 -804.

INCIDENCE OF BORERS: CORRELATION WITH QUALITY AND QUANTITY OF SUGARCANE

By

Dr. Ghulam Sarwar Tunio, A. G. Khanzada and M. Usman Usmanikhail
Sugarcane Section, Agriculture Research Institute Tandojam

ABSTRACT

Sugarcane borers are major devastators to cause considerable loss in sugarcane. Effects were made in 2003-2004, to determine the cumulative effect of borers infestation on quality and quantity of sugarcane. There was entirely a negative correlation between the intensity of infestation, the yield and T.S.S. It was anticipated that on the infestation of six internodes, approximately 4.71 percent occurred. In case there is 2 to 4 internodes are infested, the reduction in cane height ranged from 1.34 to 2.69 percent. The results showed that the cane juice quality was also affected significantly ($P<0.05$) under different borers infestation level and in case 6 internodes are infested by the borers, 7.84 percent infestation was anticipated. The differences of deterioration in cane juice (brix) were statistically significant ($P<O.Ol$); within each increased borer infestation level. There was a significant variation within attacked canes and there was significant association of borer infestation level with the cane weight as well as the quality of cane juice of certain sugarcane varieties.

Keywords: Sugarcane, borers, infestation, yield, T.S.S.

INTRODUCTION

Sugarcane, *Saccharum officinarum* L., originated In Southeast Asia and the islands of the South Pacific is cultivated in Cuba, Brazil, Hawaii and the United States, Puerto Rico, West Indies, Guiana, Mexico, Argentina, the Dominican Republic and Peru in the western hemisphere, Australia, Philippines, Indonesia, Formosa, South Africa, Mauritius, Indo-Pak and China in the eastern hemisphere (Bhatti and Soomro, 1996). In Pakistan the crop was cultivated on 1085 thousand hectares during the year 2002-2003 with a production of 57049 thousand tonnes and yield of 47.927 tonnes per hectare (Anonymous, 2003).

About 200 species of insects damage sugarcane crop in IndoPak and about two dozen species are considered as major pests. According to site and mode of feeding the insect pests can be grouped into: 1. Subterranean pests (termites and white grubs), 2. Internal feeders or borers (shoot borer, stalk borer, top borer, root borer etc.), 3. Sucking pests (Pyrilla, white flies, agied bugs, sca16 insect and mealybugs etc.) and 4. Defoliators (grass hoppers, armyworms and weevils etc.) (Anonymous, 2004).

Khanzada (1993) reported that the top borer Scirpophaga excerptalis and S. Nivella F., the stem borer Chilo infuscatellus, the root borer, Emmalocera depressella Swinh., cause heavy damage to sugarcane crop. Kabir (2004) reports. The stem borer that habitually bores into the stem and feeds on the inner tissues. Most stem borers Pyra1idae and Noctuidae and caterpillars, tunnel and feed on soft tissues.

Khanzada (1992) stated that the top borer S. excerptalis and S. Nivella F. cause considerable loss to the crop. The main activity, starts with monsoon, when the maximum temperature is below 100 F and 70-80% RH. The stem borer is a severe pest which destroys young cane shoots during April-June annually. The caterpillar feeds inside the stem and cuts off the growing point (Khanzada, 1995). Keerio (2003) reports that promising variety Thatta-10 was infested significantly more than Q-88 or BL-4 varieties. In the present study, the incidence of borers and their correlation with quality and quantity of sugarcane was investigated under agro-eco10gical conditions of Tandojam.

MATERIALS AND METHODS

The experiment consisted of four existing varieties i.e. BL-4, Triton, Thatta-l0 and PR-I000 laid out in complete randomized block design with the plot size of 6:3m^2. The crop was sown on 17- 18th September 2003 and harvested on 13th December 2004. All the approved agronomical practices were applied simultaneously. The plant samples were taken at the time of harvesting and the harvested canes were closely examined for borers infestation. The sets of 10 canes were collected at random in the following four categories according to the level of natural borers (top, stem and root) infestation: LO= Canes having zero level of infestation, Ll=Canes having two internodes infested by borers, L2= Canes having four internodes infested by borers and L3= Canes having six internodes infested by borers.

The effect of borers infestation on weight, height and T.S.S. percentage was recorded on the above collected samples in the laboratory. The data recorded were subjected to statistical analysis, the differences were analysed by using analysis of variance and the means were compared by applying D.M.R. test.

Sampling technique

All the harvested canes were closely examined for borer infestation. The sample canes were divided into four lots according to the level of borer infestation. From each lot, samples consisting of 10 canes were drawn at random. The data thus obtained were statistically analysed and interpreted.

RESULTS AND DISCUSSION

The results (Table-I) showed that there was a marked reduction in cane weight, plant height and T.S.S. with increase in borer infestation and vice versa. The losses recorded on above parameters are categorically discussed as under:

Effect on quantity (Cane weight and height)

It is obvious from the results (Table-I) that the loss in mean weight of 10 canes due to infestation of borers was statistically significant ($P<0.05$) at all levels of borer infestation. It was noted that when 6 internodes of sugarcane are infested on single cane basis, cane weight is reduced to the tone of 10-11 percent. The situation regarding reduction in weight due to different level of infestation was similar in all the varieties under observation.

The results further showed that there was a slight reduction in the cane height due to borers infestation and differences in cane height at different infestation levels were significant ($P<O.O5$). Due to increase in borer infestation, stunted plants were developed; however, the

reduction in cane height was not linear and rate of reduction was at varying rate. It was anticipated that on the infestation of six internodes, approximately 4.71 percent occurred. In case there is 2 to 4 internodes are infested, the reduction in cane height ranged from (1.34 to 2.69 percent. Varieties did not differ significantly for cane height and similar trend of effectiveness was recorded in all the varieties studied. A number of studies on the similar aspects of sugarcane have also been reported by earlier researchers, such as; Falloon (1998), Kumar and Mihm (1998), Kennedy and Nachiappan (1999), who all were of the consolidated findings that as the borer infestation increased, there was a considerable adverse effects on the sugarcane plant growth and its cane weight.

Effect on quality (T. S. S.)

The results showed that the cane juice quality was also affected significantly ($P<0.05$) under different borers infestation level and in case 6 internodes are infested by the borers, 7.84 percent infestation was anticipated. The differences of deterioration in cane juice (brix) were statistically significant ($P<O.Ol$) within each increased borer infestation level. However, the varieties had similar behaviour to different borer infestation levels ($P>0.05$).

There was a significant variation within attacked canes and there was significant association of borer infestation level with the cane weight, cane weight as well as the quality of cane juice of certain sugarcane varieties. The results achieved were in concurrence to those, who tested such parameters on the similar groups of sugarcane varieties.

Considerable efforts of research on borer infestation in sugarcane have been reviewed in the literature and similar findings have also been reported by Kumar and Mihm (1997), Falloon (1998), Kumar and Mihm (1998), Kennedy and Nachiappan (1999), Kalita and Gupta (2001), who all were of the experience that cane juice quality deteriorated considerably when borer infestation increased.

CONCLUSIONS

It was concluded from the present study that both the quantities and qualities of sugarcane affected significantly due to borers attack and losses occurred in cane weight and brix content were mainly associated with the level of infestation.

Table-1 Effect of borers infestation on weight, height and brix of cane at the time of harvesting (2003-2004)

VARIETIES		Characters studied											
		Weight of 10 canes (kg)				Height of cane (metres)				T.S.S. percentage			
		Infestation level				Infestation level				Infestation level			
		0	1	2	3	0	1	2	3	0	1	2	3
V1	BL-4	8.01	7.80	7.56	7.20	2.97	2.93	2.89	2.83	21.16	20.83	20.33	19.50
V2	Triton	7.65	7.43	7.2	6.83	2.74	2.71	2.66	2.61	20.91	20.59	20.40	19.00
V3	ThaUa-10	7.00	6.81	6.58	6.21	2.98	2.94	2.89	2.94	20.50	20.00	19.83	19.00
V4	PR-1000	5.03	4.85	4.63	4.23	2.26	2.22	2.17	2.10	19.15	18.75	18.16	17.58
LSD 0.05		0.1946	0.2167	0.2269	1.651	0.1906	0.1167	0.1167	1.056	0.7994	0.8246	2.190	
LSD 0.01		0.2690	0.2995	0.3137	0.4007	0.2636	0.2636	0.1614	1.452	1.1050	1.140	3.027	

REFERENCES

1. Anonymous. 2004. Sugarcane Entomology. Sugarcane Breeding Institute, Regional Centre, Agarsen Marg, Karnal, India.

2. Bhatti, I.M., and AH. Soomro. 1996. Agricultural inputs and field crop production in Sindh (2nd ed.). Agri. Res. Sindh, Hyderabad. pp. 230-246.

3. Falloon, T. 1998. Stalk borer damage levels as a measure of the impact of the biological control programme against Diatraea saccharalis (F.) in Jamaica. Jour. Jamaican Assoc. of Sug. Tech. 39 (3) : 35-38.

4. Gap. 2003. Agricultural Statistics of Pakistan 2002-2003. Ministry of Food, Agriculture and Livestock, Agri. & Livestock Div. Islamabad. pp. 213.

5. Kabir, S.M.H. 2004. Stem borer. Asiatic Society of Bangladesh.

6. Kalita, J. and M. K. Gupta. 2001. Pubescence in sugarcane as a plant resistance character affecting oviposition of Plassey borer, Chilo tumidicostalis Hmpsn. (Lepidoptera: Crambidae). Coop. Sug. 33 (1): 3537.

7. Keeno, H. K., R. N. Panhwar, Y. M. Memon, M. Y. Arain and R: R. Qazi. 2003. Qualitative and quantitative performance of some promising and commercial sugarcane varieties under the agro-climatic conditions of Thatta. Pakistan Joumal of Applied Sciences, 3 (10/12): 670-673.

8. Kennedy, F. J. S. and R. Nachiappan. 1999. Certain anatomical, physical and chemical basis for differential preference of early shoot borer Chilo infuscatellus Snellen in sugarcane. Mededelingen van de Facultat Landbouwwetenschappen, Rijksuniversiteit Gent. 57 (3A): 637-644.

9. Khanzada, A.G. 1993. Pest management in sugarcane: An abridged review. Pak. Sug. Journal, April-June: 11-17.

10. Khanzada, AG. 1992. An exhaustive review of research work on sugarcane Scirpophaga excesptalis Wlk. and S. novella F. Lepidoptera: Pyrauotidae. Sarhad J. of Agri. Vol. VIII (5): 529-559.

11. Khanzada, AG. 1995. Sugarcane stem borer Chilo infuscatellus Snellen. (Crambidae: Lepidoptera) - A review J. Agric. Res. 33 (1): 57-64.

12. Kumar, H. J.A. Mihm. 1997. Assessing damage by second-generation Southwestem corn borer and sugarcane borer and development of sources of resistance in tropical and subtropical maize. Insect resistant maize: recent advances and utilization. Proc. Intl. Symp. Int. Maize and Wheat Imr. Cent. pp. 195-202.

13. Kumar, H. J.A. Mihm. 1998. Assessing damage by second-generation sugarcane borer, Diatraea saccharalis Fabricius., and development of sources of resistance in sugarcane. 42 (1): 59-71.

REMARKABLE SUCCESS IN THE IDENTIFICATION OF FOUR MORE EARLY MATURING HIGH YIELDING, GOOD QUALITY SUGARCANE VARIETIES FOR PESHAWAR VALLEY OF NWFP

By
Dr. Abdul Qayum, Purdil Khan, Zainullah, Ikramullah and Sartaj Ali
Sugar Crops Research Institute, Mardan

ABSTARCT

Eight early maturing genotypes were tested during crop seasons, i.e. 2002-03, 2003-04 and 2004-05 at two locations - Mardan and Harichand in Peshawar valley of NWFP. A large number of observations were recorded on yield and quality components. In plant crops, MS91CP-582 has given higher mean germination (52.35%) and tillers (395, 290/ha) along with reasonable yields. CP85-1491 has led others by giving higher millable stalks (105, 25 O/ha), taller stalks (249.40 cm), higher cane and sugar tonnage (102.91 TCH and 13.96 TSH). CP80-1827 has shown thicker cane stalks (2.70 cm), more heavy stalk weight (1.45kg), along with higher cane and sugar tonnage in ratoon crops (77.80 TCH and 9.56 TSH) and also has given higher tonnage at farmer 's field CP87-1628 has also been found prominent in yields in case of plant and ratoon crops. Thus CP85-1491, CP80-1827, CP85-1491 and MS91CP-582 were identified as outstanding genotypes and are recommended for commercial cultivation through further tests on farmers' fields in Peshawar valley and elsewhere in NWFP.

INTRODUCTION

Sugarcane is major cash earning, well established best crop choice in cropping pattern in Peshawar valley of NWFP. Sugarcane is a raw source of decade-old refined sugar and of gur-cottage industry. In the field, cane crop is grown on commercial scale from varieties developed at the Sugar Crops Research Institute (SCRI), Mardan. SCRI is a unique institution in Pakistan, where research is conducted simultaneously on sugarcane and sugar beet.

Peshawar valley is situated at 34 and 72^{o} E is lying in the severe sub-tropical growing conditions, having a shorter growth period of about 8 months to raise and harvest the sugarcane crop. In severe cold winters (late November to March), there is likelihood of sugarcane deterioration by freezing temperatures. Therefore the valley needs sugarcane varieties, possessing the capacity of quick growth and capable to accumulate sizeable amount of sugar in their stalks before the onset of cold weather to escape the ill effect of frost (Khan, *et al.,.,,* 1994) and (Qayum, et a1.1998; 1999; 2000, and 2002). The present study was conducted with the objectives to identify suitable genotypes with high yields and good quality for releasing to growers of the area.

MA TERIALS AND METHODS

Seven early maturing almost all bi-parental genotypes were selected from a stock of prominent US source already tested in replicated variety trials. The genotypes are bearing pronounced physical characteristics (Table-I) were compared against a standard, or check

variety Mardan-93. Thus eight early maturing genotypes as G 1 to G8 were evaluated at two test sites, i. e. Mardan and Harichand farms as test location-1 (L 1) and (L2), respectively. The genotypes were laid out under RCB design with varying number of replications and plot size. Three plant crops were harvested at the two sites during three crop years - 2002-03, 2003-04 and 2004-05 as y1, y2 and as y3, respectively. Two and one ratoon crops at corresponding locations of Mardan and Harichand during 200304 and 2004-05 were also harvested. One plant crop was also raised at a farmer's field in Shakar- Tangi, Mardan in the year 2002-03. Uniform cultural practices and plant protection measures were adopted during each crop season. The varieties were also planted on a number of sites on farmers' fields under the adaptive research program.

While growing plant or ratoon crops, a large number of characters were examined as principal yield and quality components. In plant crops, germination in percent was calculated as buds sprouted in percent from the counted buds planted so far. Tillers and mill able stalks were figured out as the number observed in rows of a plot multiplied by 10,000 divided by multiple of plot size and 1000. During advanced growth stage, 5 canes randomly taken were measured for stalk height and diameter (cm) and the cane weight (kg). Monthly cane samplings were collected from fields and analyzed in the laboratory for determining quality traits for the genotypes using methods utilized by Mead-Chen (1985). Cane yield data recorded at harvest were statistically analyzed as Tons of Cane Ha-l (TCH) by using various statistics. Besides the stated facts collections, large number of other observations on pests, diseases and on tolerance of the genotypes to cold weather were also recorded, which were either analyzed statistically or not. LSD and D1-1R. tests were conducted for the comparisons of genotypes as given in Table-I.

Table-1 Some physical characteristics of 8 early maturing sugarcane genotypes Tested during 2002-2003 to 2004-2005 under growing conditions of Peshawar valley

Genotypes	Parentage	Source	Cane Color	Internode Shape	Bud Shape	Pith	Cracks
MS91CP-1157-Gl	CP84-1464 x CP84-1165	Canal Point, US	Greenish	Obtuse	Ovate	Absent	Absent
MS91CP1154-G2	Do	Do	Do	Cylindrical	Do	Do	Do
MS91CP-582-G3	Do	Do	Do	Do	Do	Do	Do
CP87-1628-G4	-	Do	Brownish	Do	Do	Do	Do
CP87-1248-G5	-	Do	Greenish	Do	Do	Do	Do
CP85-1491-G6	CP75-1553 x CP72-2086	Do	Do	Conoide	Do	Do	Present
CP80-1827-G7	CP70-1133 x CP73-1311	Do	Do	Conoide	Do	Do	Absent
Mardan 93 (check)	CP68-1154 x CP68-1026	Do	Do	Cylindrical	Do	Do	Rare

RESULTS AND DISCUSSIONS

Results regarding yield and quality components, which have been placed in Table-2 indicated that means for years and genotypes were significantly different in terms of percent germination at Mardan, but only means for years for this trait were found significant at

Harichand. Years' means were noted significantly different at Mardan and Harichand with regards to tillers, mill able stalks, cane tonnage, CCS% and sugar tonnage. Means for genotypes in terms of cane tonnage were significantly different at Mardan, but non-significant for the rest of the traits for both locations.

Table-2 Mean yield / quality components of 8 early maturing sugarcane genotypes grown at Mardan and Harichand farms in 3 plant crops harvested during the year 2002-03, 2003-04 and 2004-05 in Peshawar valley

1. Mean germination (%) at Mardan (Location-I)

Genotypes (G)	Years (Y)				
MS91CP-1157-G1	02-03 (yl)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1154-G2	50.25	59.50	53.00	162.75	54.25 ab
MS91CP-582-G3	42.38	41.17	54.83	138.38	46.13 be
CP87-1628-G4	50.59	39.33	70.17	160.09	53.36 ab
CP87-1248-G5	46.90	27.50	38.33	112.73	37.58 c
CP85-1491-G6	55.95	51.00	75.67	162.82	60.87 a
CP80-1827-G7	54.77	46.67	78.83	150.27	50.09 abc
Mardan 93 check-G8	25.43	42.83	52.00	140.06	46.69 be
Total	47.91	40.67	50.67	139.18	46.39 be
Means of years-y	393.98	348.60	443.50	1186.08	-
CV (%)	49.25 ab	43.58 b	55.44 a		-
LSD 5% for yr.	-	-	-	-	14.79%
LSD 1 % for yr.	-	-	-	-	8.38
LSD 5 % for G	-	-	-	-	-
LSD 1 % for G	-	-	-	-	12.80

Significantly higher mean germination of55.44 and 59.76% was noted at Mardan and Harichand in the year 2004-05 (Y3) and 2002-03 (Y1), respectively as compared to the lowest germination (43.58 and 38.25%) in the year 2003-04 and 2004-05 at the corresponding locations. Significantly higher germination of 60.87% was noted for CP87-1248 in comparison to the lowest germination of37.58% at Mardan. Higher non-significant germination (54.00%) was noted for Mardan-93 (check) at Harichand.

1. Mean germination (%) at Harichand (Location-2)

Genotypes (G)	Years (Y)				
MS91CP-1157-Gl	02-03 (yI)	03-04 (y2)	04-05 (y3)	Total	G-Mean
MS91CP-1154-G2	52.00	38.33	38.33	128.66	42.89
MS91CP-582-G3	47.00	33.33	38.67	119.08	39.69
CP871628-G4	68.00	41.33	44.67	154.00	51.33
CP87-1248-G5	53.00	42.00	30.67	125.67	41.89
CP85-1491-G6	70.00	50.33	32.00	152.33	50.78
CP80-1827 -G7	58.00	45.67	42.67	146.34	48.78
Mardan 93 check-G8	64.00	49.33	39.00	152.33	50.78
Total	66.00	56.00	40.00	162.00	54.00
Means of years-y	478.08	356.32	306.01	1140.41	-
CV%	59.76 a	44.54 b	38.25 b		-
LSD 5% for yr.	-	-	-	-	11. 92%
1 % for yr.	-	-	-	-	6.08
5% for G	-	-	-	-	8.43
	-	-	-	-	NS

2. Mean tillers (000/ha at Mardan (Location-I)

	Years (Y)				
Genotypes (G)	02-03 (yI)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-G1	402.41	335.21	396.11	1133.73	377.91
MS91CP-1154-G2	370.39	330.49	410.29	1111.17	370.39
MS91CP-582-G3	444.15	278.78	399.00	1121.93	373.98
CP87-1628-G4	395.33	282.60	370.39	1048.32	349.44
CP87-1248-G5	441.26	289.01	405.30	1135.57	378.52
CP85-1491-G6	383.78	318.15	378.03	1079.93	359.58
CP 80-1827-G7	368.03	285.60	410.81	1064.44	354.81
Mardan 93 check -G8	332.85	274.31	386.32	993.48	331.16
Total	3138.20	2394.15	3156.22	8688.57	-
Mean (years-y)	392.28 a	299.27 b	394.53 a	-	-
CV (%)	-	-	-	-	7.37%
LSD 5% for yr.	-	-	-	-	30.59
LSD 1 % for yr.	-	-	-	-	42.46
LSD 5 % for G	-	-	-	-	NS

2. Significantly more number of tillers (394,530 and 393,080/ha) were recorded at Mardan and Harichand in Y3 (2004-05). Higher non-significant tillers of378, 520, 377.91 and 373,980/ha were recorded at Mardan for CP 87-1248, MS 91-CP 1157 and MS 91CP 582, respectively. Maximum tillers at Harichand as 416,600 and 384,600 number/ha were recorded for MS 91-CP 582 and Mardan-93 9check), respectively.

2. Mean tillers (000/ha) at Harichand (Location-2)

	Years (Y)				
Genotypes (G)	02-03 (yI)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	345.00	366.60	408.00	1119.60	373.20
MS91CP-1154-G2	294.00	375.00	360.00	1029.00	343.00
MS91CP-582-G3	360.00	406.80	483.00	1249.00	416.60
CP87-1628-G4	327.00	356.40	304.20	987.60	329.20
CP87-1248-G5	381.00	387.00	348.00	1116.00	372.00
CP85-1491-G6	288.00	402.60	395.40	1086.00	362.00
CP80-1827-G7	321.00	312.00	396.00	1029.00	343.00
Mardan 93 check -G8	327.00	376.80	450.00	1153.00	384.60
Total	2643.00	2983.20	3144.60	8770.80	-
Mean (years-y)	330.38 ab	372.90 b	393.08 a	1119.60	-
CV (%)	-	-	-	-	10.21%
LSD 5% for yr.	-	-	-	-	40.00
LSD 1 % for yr.	-	-	-	-	55.52
LSD 5 % for G	-	-	-	-	NS

3. Significantly higher number of mill able stalks (115,830 and 116,770/ha) were noted at Mardan and Harichand in the year 2003-04 (Y2) and 2002-03 (Yl), respectively. At Mardan, maximum non-significant millable stalks of 100,800 and 100, 190/ha were observed

for MS 91-CP 1154 and CP 85-1491, respectively. Whereas, the same genotypes gave higher non-significant number of millable stalks 111,200 and 110,300/ha at Harichand.

Millable stalks at Mardan in 2002-03 were comparatively more than the years 2003-04 and 2004-05. However millable stalks at Harichand in the crop season 2004-05 were low as compared to those observed in 2002-03 and 2003-04.

3. Mean millable stalks (000/ha) at Mardan (Location-I)

	Years (Y)				
Genotypes (G)	02-03 (y 1)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	85.84	124.69	89.78	300.31	100.10
MS91CP-1154-G2	94.24	116.03	93.14	302.41	100.80
MS91CP-582-G3	92.40	105.79	96.86	295.05	98.35
CP87-1628-G4	75.34	115 .24	75.86	266.44	88.81
CP87-1248-G5	68.25	110.51	116.29	295.05	98.35
CP85-1491-G6	77.44	127.05	96.08	300.57	100.19
CP80-1827-G7	74.81	115.76	89.78	280.35	93.45
Mardan 93 check -G8	49.35	111.56	91.88	252.79	84.26
Total	617.67	926.63	748.67	2292.97	-
Mean of years-y	77.21 b	115.83 a	93.58 b	-	-
CV (%)	-	-		-	12.21%
LSD 5% for yr.	-	-		-	13.38
LSD 1 % for yr.	-	-		-	18.56
LSD 5 % for G	-	-		-	NS

3. Mean millable stalks (000/ha) at Harichand (Location-2)

	Years (Y)				
Genotypes (G)	02-03 (yl)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	106.20	105.83	98.41	310.44	103.48
MS91CP-1154-G2	121.19	94.50	88.20	303.89	101.30
MS91CP-582-G3	119.39	113.40	100.80	333.59	111.20
CP87-1628-G4	117.00	100.98	63.00	280.98	93.66
CP87-1248-G5	117.00	91.80	90.59	299.39	99.80
CP85-1491-G6	138.60	99.90	92.39	330.89	110.30
CP80-1827-G7	108.59	94.50	94.19	297.28	99.03
Mardan 93 check -G8	106.20	104.76	91.80	302.76	100.92
Total	934.17	805.67	719.38	2459.20	-
Means of years-y	116.77 a	100.71 b	89.92 b	-	-
CV (%)	-	-	-	-	9.71%
LSD 5% for yr.	-	-	-	-	10.67
LSD 1 % for yr.	-	-	-	-	14.81
LSD 5 % for G	-	-	-	-	NS

4. Significantly higher cane tonnage as 97.42 and 105.90 TCH were obtained during the crop season 2003-04 and 2002-03 at Mardan and Harichand, respectively. Low yield at Mardan in 2004-05 was due to hailstorm. Significantly higher cane yields as 100.38, 96.91 and 95.49 TCH were recorded for CP 87-1628, CP 80-1827 and MS 91-CP 1154 at Mardan (location-I) as against the lowest TCH (84.48) recorded for MS 91-CP 1157.

4. Mean Tons of Cane Ha^{-1} (TCH) at Mardan (Location-I)

	Years (Y)				
Genotypes (G)	02-03 (yl)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	88.58	87.02	77.85	253.45	84.48 c
MS91CP-1154-G2	99.42	101.36	85.69	286.47	95.49 ab
MS91CP-582-G3	99.53	97.52	89.18	286.23	95.41 abc
CP87-1628-G4	109.29	102.22	89.63	301.14	100.38 a
CP87-1248-G5	98.12	102.25	76.95	277.32	92.44 abc
CP85-1491-G6	88.73	98.45	89.10	276.28	92.09 abc
CP80-1827-G7	102.07	96.74	91.91	290.72	96.91 ab
Mardan 93 check -G8	90.70	93.83	73.69	258.22	86.07 bc
Total	776.44	779.39	674.00	2229.83	-
Mean (years-y)	97.06 a	97.42 a	84.25 b	-	-
CV (%)	-	-	-	-	4.87%
LSD 5% for yr.	-	-	-	-	5.19
LSD 1% for yr.	-	-	-	-	-
LSD 5 % for G	-	-	-	-	7.93
LSD 1 % for G	-	-	-	-	11.01

4. Mean Tons of Cane Ha-l (TCH) at Harichand (Location-2)

		Years (Y)				
Genotypes (G)		02-03 (vI)	03-04 (v2)	04-05 (v3)	Total	G-Mean
MS91CP-1157-Gl		103.70	90.20	84.60	278.50	92.83
MS91CP-1154-G2		104.10	88.90	101.40	294.40	98.13
MS91CP-582-G3		80.10	80.20	116.00	276.30	92.10
CP87-1628-G4		104.30	98.00	106.10	308.40	102.80
CP87-1248-G5		117.10	83.40	100.90	301.40	100.47
CP85-1491-G6		121.00	87.40	132.80	341.20	113.73
CP80-1827-G7		101.00	85.90	104.80	291. 70	97.23
Mardan 93 check -G8		115.90	81.60	79.80	277.30	92.43
Total	847.20	695.60		1140.41		-
Mean		105.90 a	86.95 b	103.30 ab	-	-
CV%	-	-		-		12.80%
LSD 5% for yr.		-	-	-	-	13.55
"	-	-		-		18.80
		-		-		
"	02-03 (vI)	03-04 (v2)		278.50		NS
	103.70	90.20		294.40		

At Harichand, higher non-significant cane yields as 113.73, 102.80, 100.47,98.13 and 97.23 TCH were obtained from CP 85-1491, CP 87-1628, CP 87-1248, MS 91-CP 1154 and CP 80-1827, respectively.

5. Mean CCS% at Mardan (Location-I)

	Years (Y)				
Genotypes (G)	02-03 (yl)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	13.28	13.05	12.18	38.51	12.84
MS91CP-1154-G2	12.92	13.15	12.27	38.34	12.78
MS91CP-582-G3	12.88	13.51	11.71	38.10	12.70
CP87-1628-G4	12.58	12.94	11.87	37.39	12.46
CP87-1248-G5	11.83	12.72	12.11	36.66	12.22
CP85-1491-G6	13.04	13.54	12.89	39.97	13.58
CP80-1827-G7	12.65	13.21	12.41	38.27	12.76
Mardan 93 check -G8	13.52	13.28	11. 86	38.66	12.89
Total	102.70	105.40	97.30	305.40	-
Mean of years-y	12.84 a	13.18 a	12.16 b	-	-
CV (%)	-	-	-	-	2.73%
LSD 5% for yr.	-	-	-	-	0.37
LSD 1 % for yr.	-	-	-	-	0.52
LSD 5 % for	-	-	-	-	NS

5: CCS% at Harichand (Location-2

	Years (Y)				
Genotypes (G)	02-03 (yl)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	13.43	13.47	13.43	40.33	13.44
MS91CP-1154-G2	13.50	13.74	13.37	40.61	13.54
MS91CP-582-G3	13.94	13.60	13.35	40.89	13.63
CP87-1628-G4	13.87	13.41	13.75	41.03	13.68
CP87-1248-G5	13.38	13.55	13.27	40.20	13.40
CP85-1491-G6	13.79	13.76	13.82	41.37	13.79
CP80-1827-G7	13.68	13.58	13.30	40.56	13.52
Mardan 93 check -G8	14.02	13.49	13.62	41.13	13.71
Total	109.61	108.60	107.91	326.12	-
Mean of years-y	13.70 a	13.58 a	13.49 a	-	-
CV (%)	-	-	-	-	1.32%
LSD 5% for yr.	-	-	-	-	NS
LSD 5 % for G	-	-	-	-	NS

5. Significantly higher CCS of 13.18 and 13.70% were noted for the crop year 2003 04 and 2002-03 at Harichand (location-2), respectively. At Mardan comparatively higher, but non-significant CCS of 13.58, 12.89 and 12.84% were recorded for CP85-1491, Mardan-93 (check) and MS91CP-1157, respectively. At Harichand greater, yet non significant CCS of 13.79, 13.71, 13.68 and 13.63% were noted for CP85-1491, Mardan93 (check), CP87-1628 and MS91CP-582, respectively.

6: Tons of Sugar Ha^{-1} (TSH) at Mardan (Location-I)

	Years (Y)				
Genotypes (G)	02-03 (vI)	03-04 (y2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	11.76	11.33	11.71	34.80	11.60
MS91CP-1154-G2	12.85	13.33	10.48	34.66	12.22
MS91CP-582-G3	12.82	13.18	9.13	35.13	11.71
CP87-1628-G4	13.75	13.23	11.10	38.08	12.69
CP87-1248-G5	11.61	13.01	11.52	36.14	12.05
CP85-1491-G6	11. 57	13.33	11.75	36.65	12.22
CP80-1827-G7	12.91	12.78	11. 72	37.41	12.47
Mardan 93 check -G8	12.27	12.89	11. 85	37.01	12.34
Total	99.54	103.08	89.26	291.88	-
Means of vears-v	12.44 ab	12.89 a	11.16 b	-	-
CV (%)	-	-	-	-	%
LSD 5% for yr.	-	-	-	-	0.93
LSD 1 % for yr.	-	-	-	-	1.29
LSD 5 % for G	-	-	-	-	NS

6: Tons of sugar Ha-l (TSH) at Harichand (Location-2)

	Years (Y)				
Genotvpes (G)	02-03 (vI)	03-04 (v2)	04-05 (y3)	Total	Mean (G)
MS91CP-1157-Gl	13.93	12.15	11.36	37.44	12.48 b
MS91CP-1154-G2	14.05	12.21	13.56	39.82	13.27ab
MS91CP-582-G3	11.17	10.91	15.49	37.57	12.52 b
CP87-1628-G4	14.47	13.14	14.59	42.20	14.07 ab
CP87-1248-G5	15.67	11.30	13.39	40.36	13.45 ab
CP85-1491-G6	16.69	12.03	18.35	47.07	15.69 b
CP80-1827-G7	13.82	11.67	13.94	39.43	13.14 ab
Mardan 93 check -G8	16.25	11.01	10.S7	3S.13	12.71 b
Total	116.05	94.42	111.55	322.02	-
Means of vears-v	14.51 a	11.80 b	13.94 a	-	-
CV (%)	-	-	-	-	12.65%
LSD 5% for yr.	-	-	-	-	10.67
LSD 1 % for yr.	-	-	-	-	14.S1
LSD 5 % for G	-	-	-	-	NS

6. Significantly greater sugar yields as 12.89 and 14.91 Tons of Sugar Ha^{-1} (TSH) were recorded for the crop season 2003-04 and 2002-03 at Mardan (location-I) and Harichand (location-2), respectively. At Mardan, higher yet non-significantly greater sugar yields as 12.69 and 12.47 TSH were obtained from CP 87-1628 and CP 80-1827, respectively. At Harichand, significantly greater sugar yields as 15.69 and 14.07 TSH were obtained from CP 85-1491 and CP 87-1628 as against the lowest sugar yield TSH (12.48) recorded for MS 91-CP 1157. Sugar yields for genotypes during the three years plant at Harichand were far greater than Mardan, because of higher CCS% and on the grounds of higher cane tonnage.

When means for yield and quality components were combined and the results placed in Table-3, means for the genotypes were found non-significant for all components.

Germination %
Percent germination as is most commonly considered as the basis of a good crop was found non-significant. However, higher germination of 55.83, 52.35 and 50.20% were observed for CP87-1248, MS91CP-582 and Mardan-93 (check), respectively. CP87-1628 gave the least germination of 39.74%. Constantly lowest germination% by CP87-1628 in the years, locations and in their combination might be due to its inherited character. Therefore care must be taken at sowing the crop of this genotype.

Number of tillers (000/ha)
The character (mean number of tillers), which contributes much to number of millable stalks and hence further on into cane and sugar yields were found higher, yet non-significant as 395,290 and 375.560/ha as observed for MS91CP-582 and MS91CP-1157. The lowest tillers of 339,220 number/ha were recorded for CP 87-1628. The remaining genotypes had altogether shown closer number of tillers.

Number of millable stalks (000/ha)
Non-significantly greater mean millable stalks of 105,250, 104,780 and 101,790/ha were recorded for CP85-1491, MS91CP-582 and MS91CP-1157. Lowest mean millable stalks of 91,240/ha were found for CP87-1628 because of its lowest germination and also due to its lowest tillering. All the genotypes have given closed millable stalks, which mean that the genotypes were equally capable to produce greater number of millable stalks per unit area wherever and when they were grown.

Stalk height (cm)
Stalk height is the trait, which contributes handsomely to the cane weight. Gain in stalk height is a real challenge in breeding of sugarcane varieties for Peshawar valley in NWFP, which is having a shorter growth period of about eight months. Here testing and evaluating the early group of varieties, non-significantly higher mean stalk height of 249.40,237.21 and 235.95 cm had been observed for CP85-1491, MS91CP-1157 and MS91CP-1154. Lowest stalk height of 200.55 cm was recorded for Mardan-93 (check). Rest of genotypes had also given closer and reasonable stalk height, a trait which subscribes more to the yields.

Stalk diameter (cm)
This trait contributes much to the cane weight. Greater, but non-significant mean thicker stalks of greater diameters (2.70 cm) were recorded for CP80-1827. This was closely followed by genotypes with mean diameters of 2.62 cm in each case of MS91CP-1154 and CP87-1628. Remaining genotypes had also shown closer stalk diameter. Comparatively thinner mean stalks of 2.43 cm were found for Mardan-93 (check).

Stalk weight (kg)
Bulk of sugarcane is largely resting in its single stalk weight, which is leading to maximum weight at the crop harvest. Heavier mean single cane stalk-weight of 1.45, 1.38 and 1.35 kg was recorded for CP80-1827, MS91CP-1154 and CP87-1628, respectively. Lighter mean cane weight of 1.13 kg was observed for MS91CP-1157. Others genotypes also stood closer in single cane weight.

Tons of Cane ha^{-1} (TCH)
The ultimate component at each crop harvest is the cane weight or cane yield. Higher non-significant cane yields as 102.91, 101. 59 and 97.07 TCH were observed for CP85-1491, CP87-1628 and CP80-1827, respectively. The lowest cane yield (88.66 TCH) was obtained

from MS91CP-1157. Remaining genotypes, particularly MS91CP-1154 and CP87-1248 yielded closer cane yields as 96.81 and 96.46 TCH. MS 91-CP 582 gave reasonably greater cane yield as 93.76 TCH. Mardan-93 (check) with its 89.25 TCH slightly surpassed MS91CP-1157.

CCS%

CP85-1491 with its CCS of 13.69% was found leading genotypes in terms of sugar content or quality. This was followed closely by Mardan-93 (check) with next higher CCS of 13.30%. In recent past none of the cane varieties have competed Mardan93. Still more closer was MS91CP- 582 with CCS of 13.17%, which was again followed closely by MS91CP-1154 with CCS of 13.16%. MS91CP-1157 and CP80-1827 each with CCS of 13.14% along with CP87-1628 with CCS (13.07%) have been noted as good quality genotypes.

Sugar yield as Tons of Sugar ha^{-1} (TSH)

Sugar yield is the end product is a multiple of cane yield and CCS% and is considered as a best quality count. Greater non-significant sugar yields as 13.96 and 13.38 TSH were obtained from CP85-1491 and CP87-1628. Next maximum TSH of 12.85 and 12.81 were recorded for MS91CP-1157 and CP80-1827, respectively. Remaining genotypes have also given reasonably higher sugar yields per unit area. MS91CP-582 remained second to CP87-1248 in germination. MS91CP-582 was found leading genotype in terms of tillering. CP85-1491 led the rests in terms of millable stalks, which was followed by MS91CP-582. CP85-1491 also gave higher cane stalks, but in respect of stalk diameter CP80-1827 surpassed all others. CP80-1827 was also noted as the leading genotype in terms of single stalk weight and was MS91CP-1154 and CP87-1628. CP85-1491 yielded higher cane yield and was followed by CP87-1628 and CP80-1827. The rest of the genotypes were also found reasonably good in cane yield. CP85-1491, Mardan-93 and MS91CP-582 stood superior to others in respect of CCS%. CP85-1491, CP87-1628 and MS91CP-1154 have yielded higher sugar yields per unit area along with reasonably suitable sugar of others. Thus CP85-1491, CP80-1827, CP87-1628 and MS91CP-582 were found outstanding genotypes: The genotypes had shown least variation, most probably due to limited test locations and years.

Table-3 Combined means for some principal yields and quality components of 8 early maturing sugarcane genotypes grown at Mardan and Harichand in 3 plant crops harvested from 2002-03 to 2004-05

Genotypes (G)	Yield and quality com Jonents								
	Per cent Germina-tion	No. of Tillers (000/ha)	Millable stalks (000/ha)	Stalk height (cm)	Stalk diameter (cm)	Stalk weight (k2)	Tons of Cane ha-l TCH	CCS (%)	Tons of Sugar ha-l (TSH)
MS91CP-1157-Gl	48.57	375.56	101. 79	237.21	2.39	1.13	88.66	13.14	12.04
MS91CP-1154-G2	42.91	356.70	101.05	235.95	2.62	1.38	96.81	13.16	12.85
MS91CP-582-G3	52.35	395.29	104.78	224.45	2.56	1.31	93.76	13.17	12.12
CP87-1628-G4	39.74	339.22	91.24	233.25	2.62	1.35	101.59	13.07	13.38
CP87-1248-G5	55.83	375.26	99.08	235.60	2.51	1.23	96.46	12.81	12.75
CP85-1491-G6	49.44	360.79	105.25	249.40	2.49	1.25	102.91	13.69	13.96
CP80-1827-G7	48.74	348.91	96.24	216.95	2.70	1.45	97.07	13.14	12.81
Mardan 93 check -G8	50.20	357.88	92.59	200.55	2.43	1.23	89.25	13.30	12.53
CV (%):	10.20	5.67	4.09	6.07	3.94	10.75	5.56	1.73	5.28
LSD 5% for Genotypes:	NS	NS	NS	NS	NS	NS	NS	NS	NS

Results pertaining to ratoon crops raised up at Mardan and Harichand during 2003-04 to 2004-05. One plant was also grown on farmer's field (Table-4) indicated that higher cane yields as 77.80,75.43,74.17 and 68.94 TCH were recorded for CP80-1827, CP87-1628, MS91CP-582 and CP85-1491, respectively as against the low cane yield (TCH = 63.14) recorded for Mardan-93 (check). Higher CCS of 13.19 and 13.01% were observed for CP 85-1491 and Mardan-93 (check). Maximum sugar yields as 9.56,9.13, 9.09 and 9.06 TSH were obtained from CP80-1827, MS91CP-582, CP87-1628 and CP85-1491, revealing that these genotypes are also good in ratoon-ability.

Higher cane yields as 82.51 and 82.07 TCH with maximum sugar yields as 9.62 and 10.50 TSH were recorded in plant crop on a farmer's field for CP87-1628 and CP80-1827, respectively. Only MS91CP-582 got a set back in yields, which may be due to a poor crop management at this locality.

Table-4 Average Tons of Cane and Tons of Sugar Ha^{-1} (TCH and TSH) as well as CCS% of 8 early maturing genotypes in 3 ratoon crops: 2 ratoons (2003-04 & 2004-05) at Ll plus 1 ratoon at L2 04/05) and 1 plant crop at farmer's field at ShakarTangi in 2002-03

Trait/ Treatment	Genotypes							
	MS 91-CP1157	MS 91-CP1154	MS 91-CP582	CP 87-1628	CP 87-1248	CP 85-1491	CP 80-1827	Mardan 93 check
1- Tons of Cane Ha-l(TCH)								
LIYIRt.	84.71	78.86	75.95	83.66	78.97	80.24	85.90	79.90
LIY2Rt.	36.86	52.43	49.55	54.14	54.45	58.64	57.51	48.51
L2 Rt.	64.00	71.00	97.00	88.50	61.00	68.00	90.00	60.50
Mean	61. 86	67.80	74.17	75.43	64.81	68.96	77.80	63.14
Pt at S/Tangi	71.50	60.23	54.51	82.51	63.44	63.70	82.07.	62.75
2- CCS %								
LIYIRt.	10.93	10.62	10.69	10.33	11.95	12.70	11.38	12.43
LIY2Rt.	12.59	12.35	13.06	12.90	13.24	13.64	12.88	13.64
L2 Rt.	11.47	12.74	13.20	13.17	12.20	13.22	12.77	12.97
Mean	11.66	11.90	12.32	12.13	12.46	13.19	12.34	13.01
Pt at S/Tangi	13.14	12.98	12.55	11.66	11.07	12.54	12.79	12.87
3- Tons of Sugar Ha-l(TSH)								
LIYIRt.	9.26	8.38	8.12	8.64	9.44	10.19	9.78	9.93
LIY2Rt.	4.64	6.48	6.47	6.98	7.21	8.00	7.41	6.62
L2 Rt.	7.34	9.19	12.80	11.66	7.44	8.99	11.49	7.91
Mean	7.08	8.02	9.13	9.09	8.03	9.06	9.56	8.15
Pt at S/Tangi	9.62	7.82	6.84	9.62	7.02	7.99	10.50	8.08
Ll, L2 = Location-l,2; Yl,Y2 = year-l and year-2; Rt. = Ratoon; Pt. = Plant and S/=Shakartangi								

CONCLUSION AND RECOMMENDATIONS

Eight early maturing genotypes were tested during crop seasons, i.e. 2002-03, 2003-04 and 2004-05) at two locations (Mardan, Harichand) in Peshawar valley of NWFP. During the tests, a large number of observations were recorded on yield and quality components. CP85-1491, CP 80-1827, CP 87-1628 and MS 91-582 have proven their worth in plant and ratoon crops in terms of yield and quality components. These genotypes are recommended for commercial cultivation subject to their further testing on farmers' fields.

REFERENCES

1. Chen, C. P. 1985. Meade-Chen-Cane Sugar Hand Book. 11th Ed. Jhon Wiley and Sons, N.Y., PP 777, 778, 926, 999.

2. G.S. Dr., G. Rehman, and A Qayum. 1994. Another Milestone in the Improvement of Cane Yield and Sugar Recovery in NWFP Through the Release of Mardan-93. Proc. PSST 29th Ann. Conv. 1994: 118-127

3. Qayum, ADr., Dr. M.B. Kumbhar. Dr. Imran, M., Dr. G. Ahmad, and M. Arif. 1998. Phenotypic Stability of Early Maturing Sugarcane Varieties in Peshawar Valley. Proc. PSST 33rd Ann. Conv. 1998: 76-85

4. Qayum, ADr., G. Rehman, Dr.G. Ahmad, and M.Ali. 2000. Yield and Quality Performance of Early Maturing Sugarcane Varieties Grown in Peshawar Valley Proc. PSST 35th Ann. Conv. 2000: 141-149

5. Qayum, ADr., G. Rehman, Dr.G. Ahmad, and S. Ali. 2002. Introduction of Another Good Cane Variety MCP 421 for Commercial Cultivation in Peshawar Valley. Pak Sugar J. Vol. 17: 39-43

PERFORMANCE OF SUGARCANE CLONES IN NATURALLY DROUGHT AFFECTED FIELD

By

M S Islam, Mst. K. Begum, M S Arefin, M A Hossain, M R Alam and M A S Miah
Bangladesh Sugarcane Research Institute Ishurdi-6620, Pabna, Bangladesh.

ABSTRACT

In a field study, drought tolerance of sugarcane clones was screened at the two location, Rajabari, Rajshahi under Barind Tract areas farmers field and Patuadangi farm, of Regional Sugarcane Research Station (RSRS), Thakurgaon. Clones I-8/95, I-122/95 and I-200/96 showed highly tolerant reaction. Drought stress condition at Barind tract areas produced cane yield 139.3, 118.3, 115.0 t ha^{-1} respectively and RSRS, Thakurgaon, produced cane yield 92.8, 90.9 and 59.9 t ha^{-1} respectively. Results indicated strong possibilities of present technique to screen sugarcane clones for superior tolerance to drought. Therefore, these physiological trials may be take into consideration while selecting sugarcane varieties for drought stress.

Key word: Sugarcane, Drought, Tolerance, Tiller, Yield.

INTRODUCTION

The production of crops in limited by drought in many parts of the world. Even temporary drought can cause substantial losses in crop yields. In some areas this can amount to many million dollars (Moseley, 1983). This can only be through better management practices, which increase the availability of stored soil moisture and development of crop varieties, which can produce economic yield under such condition (Atsmon, 1973; Hurd, 1976; Parsons, 1982; Quisenberry, 1982). Sugarcane plants shows a complex mechanism for its adaptability in serious soil climate conditions. It can withstand conditions of sever drought and some varieties may grow in water logged conditions as well. Physiological drought is fact the imbalance in water uptake and transpiration losses due to high wind and or high temperature. It may give sins of sunburn. Sometimes heavy rainfall and or floods cause water logging leading to hydrological drought. Drought stress may hamper the biochemical processes of cane plant which has deleterious effect on the growth and synthesis of its end product. The degree of effect varies with the extent of drought and the period it prolonged (Malik, 1992).Sugarcane varieties show inherent differences in their yield potential under different degrees of stress conditions (Bamber, 1982; Humbert, 1963). It was observed that tillering and growth of cane was reduced by low irrigation level, but the drought resistant varieties were less affected in respect of those characters than the others (Gill, 1962; Malik, 1992). The performance of sugarcane varieties is mostly dependant on climatological factors during different growth phases along with soil conditions and agronomical management. Thus the varieties performing best at one location may not have been same performance at another location. It is, therefore, highly essential to test some promising sugarcane varieties under a given set of agronomic condition. (Joshi, et. al., 1994). Direct screening in the field conditions is, therefore, very difficult, and in many cases, doubtful**.**

MATERIALS AND METHODS

The experiment was conducted by growing sugarcane Barind tract area, Rajshahi, in the drought (condition) areas and others RSRS Thakurgaon another drought area of Bangladesh.

There were 12 promising clones which were evaluated in RCBD design of field layout with three replication. The soil of the experiment sites were sandy, loam in Rajshahi. and RSRS, Thakurgaon sandy loam location. The experiment was planted 1st November at Rajshahi and 3rd November at Thakurgaon location. Furrow method was adopted for planting two budded setts. The crop received 325kg urea, 250kg TSP, 190kg MP, 180kg Gypsum and 9 kg $Znso_4$ per hectare. All necessary cultural practices were done. Observed were recorded tolerance rating 15 days interval, in drought period, tiller count, millable cane and yield.

RESULTS AND DISCUSSION

To screen drought tolerant sugarcane clones, field trials were conducted with BSRI bred clones under ZYT-II and III at farmers field, Rajabari (Rajshahi) and clones under ZYT-II and III at Patuadangi farm of Regional Sugarcane Research Station (RSRS), Thakurgoan during 2001-2002 cropping season. The results of the trials have been presented in the Tables 1 and 2. It is seen from the Table 1 that clones I-8/95, I-122/95 and I-200/96 showed highly tolerant reaction (having tolerance rating 1) against field drought stress condition at Rajabari (Rajshahi) under Barind tract areas and produced cane yield 139.3, 118.3 and 115.0 t ha^{-1} respectively. The rest clones showed tolerant reaction having tolerance rating 2 except clone I-47/96 and produced cane yield 71.8 to 132.4 t ha^{-1}. The check varieties Isd-20 and Isd-31 showed highly tolerant reaction and produced cane yield 101.4 and 118.0 t ha^{-1} respectively. The table 2 shows the results of trial conduced at RSRS farm, Thakurgoan and it is seen that clones I-8/95, I-122/95 and I-200/96 showed highly tolerant reaction (having tolerance rating 1). These clones produced cane yield 92.8, 90.9 and 59.9 t ha^{-1} respectively. The check variety Isd-31 showed tolerant reaction (having tolerance rating 2) and produced cane yield 94.8 t ha^{-1}. The clones I-22/94, I-13/96, I-47/96, I-137/96 and I-143/96 showed tolerant reaction (having tolerance rating 2). It is also seen from the tables 1 and 2 that although clones I-8/95, I-122/95 and I-200/96 showed highly tolerant reaction at both the locations, but recorded 27.4 to 55.1 t. ha^{-1} yield difference between two locations. Form the above discussion it can be indicate that sine of sunburn , month of February, March, April and May, grading the clones at an interval of 15 days, may be appropriate indicators of drought resistance and therefore, could be used as selection criteria for isolating drought resistant sugarcane varieties particularly at the drought stage. Malik (1992) reported that physiological drought gives sins of sunburn, the result are also fair agreement with the results of the present investigation of tolerance rating scale. Tolerance rating 1, clones I-8/95, I-122/95 and I-200/96 were Rajabari, Rajshahi produced yield 139.3, 118.3, and 115.0 t ha^{-1}, RSRS, Thakurgaon produced yield 92.8, 90.9 and 59.9 t ha^{-1}. Joshi et. al., (1994) reported that the performance of sugarcane varieties is mostly dependant on climatological factors during different growth phases along with soil conditions and agronomical management. Thus the varieties/clones performing best at one location may not have been performance at another location which is in agreement with our findings.

Anonymous (2004) obtain I-8/95, I-122/95 and I-200/96 different location average yield 101.70, 101.29 and 70.82 t ha^{-1} which is little variation to our findings. This variation might be due to some other factors like climate, soil condition, weather, fertilizer and drought stress

condition etc. In the present investigation the effect of drought or rainfall during 2001-2002 was compared for quality characters and climatic factors has been presented in table 3 and 4.

Clones I-8/95, I-122/95 and I-200/96 produced tillers 174.4 ($10^{-3}ha^{-1}$), 173.8($10^{-3}ha^{-1}$) and 197.6 ($10^{-3}ha^{-1}$) and millable canes 135.0($10^{-3}ha^{-1}$), 139.5($10^{-3}ha^{-1}$) and 173.1($10^{-3}ha^{-1}$) Rajabari, Rajshahi location. Tillers 110.7($10^{-3}ha^{-1}$) 192.7($10^{-3}ha^{-1}$) and 178.2($10^{-3}ha^{-1}$) and millable canes 78.7($10^{-3}ha^{-1}$), 1298.9($10^{-3}ha^{-1}$) and 110.1($10^{-3}ha^{-1}$), RSRS, Thakurgaon location. According to anonymous (2004) clones I-8/95, I-122/95 produced tillers 175.00($10^{-3}ha^{-1}$), 210.00($10^{-3}ha^{-1}$) and millable canes 113.00($10^{-3}ha^{-1}$), 128.50($10^{-3}ha^{-1}$) respectively. The findings of the present study are in agreement with the report of Gill (1962) and Malik (1992). Tillering and growth of cane was drought resistant varieties were less affected which is very close to our findings. The result of the performance of clones under evaluation for varietal selection programme physiologist help breeders for to improve drought resistant varieties.

REFERENCES

1. Annonymous, 2004. BSRI. Annual Report 2002-2003. Bangladesh Sugarcane Research Institute. pp. 28-29.
2. Atsmon, D. 1973. Breeding for drought resistance in field crops. In: Rom Moar (ed.) Agricultural Genetics Selected Topics. John Wiley and Sons, New York. pp. 157-176.
3. Bamber, N. G. I. 1982. Drought tolerance of commercial varieties in South Africa. Proc. Ann. Congress. S. Africa Sugar tech. Assoc. 56: 112-117.
4. Gill, H. S. 1962. The influence of soil drought on the growth, yield and quality of cane varieties in relation to their drought endurance. Indian J. Agron. 7: 148-159.
5. Hurd, E. A. 1976. Plant Breeding for drought resistance. In: Kozlowski, T. T. (ed.). Water deficit and Plant Growth Academic Press New York. pp. 317-353.
6. Humbert, R. P. 1963. The growing of sugarcane. Elsevier Publishing Co. Amsterdam, London, New York. pp. 312, 51.
7. Joshi, S.; Bendigeri, A. V. and Hapase, D. G. 1994. Studies on some physiological parameters in six varieties of sugarcane. Sista Sugar J. 20(1): 168-171.
8. Malik, K. B. 1992. Effect of drought stress on the yield and recovery of sugarcane. Pak. Sugar Journal. pp.17.
9. Moseley, G. 1983. Variation in the epicuticular wax content of white and red clover leaves. Grass Forage Sci. 38: 201-204.
10. Parsons, L. R. 1982. Plant response to water stress. In: Christiansen M. N., and Lewis, C. F. (eds.). Breeding Crops for Favourable Environments. John Wiley and Sons, New York. pp.175-192.
11. Quisenberry, J. M. 1982. Breeding for drought resistant and water use efficiency. In: Christiansen, M. N., and Lewis, C. F. (eds.). John Wiley and Sons, New York. pp. 193-212.

Table-1 Performance of BSRI bred sugarcane clones under farmer's field drought stress condition (Rajabari, Rajshahi)

Clones/ Varieties	Tolerance rating scale (1-5)*	Tillers (10^3 ha^{-1})	Millable Canes (10^3 ha^{-1})	Yield (TCH)
I-22/94	2	141.0	121.9	104.8
I-8/95	1	172.4	135.0	139.3
I-12/95	2	160.5	132.6	109.4
I-22/95	2	211.2	169.7	126.0
I-122/95	1	173.8	139.5	118.3
I-164/95	2	118.3	101.0	92.9
I-13/96	2	141.4	124.3	87.0
I-34/96	2	168.1	143.8	132.4
I-37/96	2	122.1	102.9	80.2
I-47/96	3	158.9	136.8	111.3
I-143/96	2	126.0	108.8	71.8
I-200/96	1	197.6	173.1	115.0
Isd-20	1	174.8	130.0	101.4
Isd-31	1	190.2	143.8	118.0

*Tolerance rating scale (1-5) is based on greenness of plants and other data collected, where 1= Highly tolerant, 2= Tolerant, 3= Moderately tolerant, 4= Intolerant and 5=Highly intolerant

Table-2 Performance of BSRI bred sugarcane clones under field drought stress condition (RSRS farm, Thakurgaon)

Clones/ Varieties	Tolerance rating scale (1-5)*	Tillers (10^3 ha^{-1})	Millable Canes (10^3 ha^{-1})	Yield (TCH)
I-22/94	2	132.2	94.8	80.8
I-8/95	1	110.7	78.7	92.8
I-12/95	3	91.1	60.5	55.3
I-22/95	3	106.3	75.9	47.8
I-122/95	1	192.7	128.9	90.9
I-164/95	4	120.6	86.9	90.1
I-13/96	2	170.6	104.3	69.1
I-34/96	4	134.5	90.8	92.4
I-47/96	2	90.4	67.0	63.5
I-143/96	2	117.7	71.7	47.7
I-200/96	1	178.2	110.1	59.9
Isd-20	2	170.1	105.2	92.3
Isd-31	2	180.7	110.8	94.8

*Tolerance rating scale (1-5) is based on greenness of plants and other data collected, where 1= Highly tolerant, 2= Tolerant, 3= Moderately tolerant, 4= Intolerant and 5=Highly intolerant.

Table-3 Monthly records of meteorological data during the experimental period from October 2001to December 2002 at Thakurgaon, Bangladesh

Month	Temperature (^{0}C)			Rainfall (mm)
	Maximum	Minimum	Average	
October, 2001	33.43	19.89	26.66	587
November, 2001	29.18	15.22	22.20	0.00
December, 2001	24.52	9.77	17.14	0.00
January, 2002	23.98	9.18	16.58	6.00
February, 2002	25.00	11.30	18.15	8.00
March, 2002	30.62	16.04	23.33	27.0
April, 2002	31.20	20.12	25.66	122
May, 2002	32.93	22.05	27.49	78.0
June, 2002	32.70	23.40	28.05	369
July, 2002	33.19	22.96	28.07	652
August, 2002	34.19	23.91	29.05	144
September, 2002	30.81	23.20	27.00	425
October, 2002	33.09	20.66	26.87	26.0
November, 2002	30.70	16.47	23.58	0.00
December, 2002	25.11	13.29	19.20	0.00

Table-4 Monthly records of meteorological data during the experimental period from October 2001to December 2002 at Rajshahi, Bangladesh

Month	Temperature (^{0}C)			Rainfall (mm)
	Maximum	Minimum	Average	
October, 2001	31.91	24.06	27.98	185.0
November, 2001	29.73	19.17	24.45	0.66
December, 2001	24.97	12.90	18.93	0.00
January, 2002	26.40	12.27	19.33	10.80
February, 2002	28.77	13.10	20.93	1.40
March, 2002	33.17	18.37	25.77	159.4
April, 2002	33.53	22.60	28.06	96.8
May, 2002	32.90	24.13	28.50	195.4
June, 2002	33.47	25.73	29.60	182.3
July, 2002	33.43	26.57	30.00	316.4
August, 2002	32.63	26.20	29.41	237.6
September, 2002	33.10	25.63	29.36	279.1
October, 2002	31.87	22.37	27.12	48.70
November, 2002	29.10	17.83	23.46	17.60
December, 2002	25.63	12.93	19.28	0.00

SUGAR INDUSTRY ABSTRACTS

By

Mohammad Awais Qureshi* and Dr. Shahid Afghan**
*Shakarganj Mills Limited, **Shakarganj Sugar Research Institute, Jhang

FACTORY PROCESSING

Improving the quality of c sugar magma for use as seed crystal material

R. Broadfoot and G. Petersen

THE sugar crystals produced by continuous C massecuite centrifugals typically comprise large numbers of crystal chips and broken grain, as well as the main crystal population. Consequently, the C sugar magma produced from this material is of poor quality for use as crystal seed for subsequent crystal growth, unless washing is undertaken firstly to dissolve and remove the chips and small crystals. Generally mills undertake this magma preparation step in batch pans, but the washing step is one of the most difficult to control on the pan stage due to the rapid crystal dissolution that occurs. A magma preparation system has been developed that involves the continuous flow of magma through a mixer where controlled dissolution is undertaken, and then through a specially designed cooling crystalliser where the dissolved sucrose is recrystallised onto the remaining crystals. Condong Mill has operated the SRI designed magma preparation system since 1995, with good results. The prepared magma, which is stored in a buffer tank prior to use in a batch pan for seed development, typically is of 25% crystal content, has a mean size of 0.25 mm, and contains very few small crystals. No washing of the prepared magma is undertaken in the batch pan prior to the commencement of crystal growth. The main benefits to Condong Mill from implementing the system have been a boost of about 9% to the production capacity of the pan stage and improved quality of the sugar produced by the factory. The paper describes the design of the system and the control functions, together with the results from Condong Mill. The application of the system to other raw sugar factory arrangements, e.g. as the seed supply to continuous pans, is also discussed.

Efficient centrifugal operation

G.C. Grimwood, Mj. Thewlis And A.J. Dean Thomas Broadbent and Sons Ltd, England E.

ASPECTS of batch centrifugal operation are considered in terms of washing, discharging and energy consumption with a view to lowering the operating cost within the sugar factory. In addition the impacts of MA and CV on losses in continuous centrifugals are assessed. The impact of poor batch centrifugal operation is calculated in terms of the cost of evaporating excess wash water, recrystallising dissolved sugar, and the load on the factory. The cost of sugar lost through continuous centrifugal screens due to both incorrect screen selection and poor masscCuite boiling is estimated. Results indicate that optimised modem batch centrifugals have higher sugar yields, minimising recirculation of sugars, thus lowering the

overall production costs and load on the factory. Improved sugar boiling and better screen selection will prevent sugar being lost to the final molasses, resulting in the recovery of more sugar. The importance of good centrifugal operation should not be underestimated as the costs of poor operation are very high, in some cases running to many thousands of US dollars per year.

ENGINEERING

Modelling and experimental evaluation of nitrogen oxides emissions in Brazilian bagasse boilers

F.N. Teixeira and E.E.S. Lora

THIS PAPER presents the results of the experimental and analytical evaluation of nitrogen oxides emission from bagasse boilers. There are limited data on NOx emissions from sugarcane bagasse boilers in the Brazilian and international technical literature and little information on the influence of the types of combustion system, operating parameters (air excess), and fuel composition on the prevention of NO x formation. In this paper, data from a Brazilian sugar factory are compared with predictions from different models and data from !' technical literature. The influence of boiler operation parameters (excess air variation and' boiler load) on emissions levels is also studied. These data may establish a basis to assist in the selection of the appropriate methods for the prevention and control of the NOx emissions in bagasse boilers. It may be concluded that the 'fuel mechanism' is the most important one m NOx formation during bagasse combustion in industrial furnaces, although thermal mechanism also contributes to NOx formation.

Development and prospects for drying bagasse by steam

Boris Morgenroth and Druce Ba Tstone

DRYING of bagasse offers the advantage of an increase in calorific value and an improvement in boiler efficiency. Recovery of steam from the dryer for process heating increases the availability of bagasse as a fuel for cogeneration. A comparison of the impacts on the overall energy demand of a cane sugar plant employing flue gas drying and steam drying is given. The possibilities for integration of a bagasse steam dryer in the steam system of a cane factory are discussed. First test results and experiences gained with a steam drying pilot plant of 0.3 t/h water evaporation capacity are presented. Test conditions include drying of bagasse and fresh sugarcane to below 10% moisture. The plant has been operated for more than 1000 hours. In contrast to flue gas and low temperature drying, the steam dryer offers the advantage of a closed system. Air emissions can be reduced to a minimum by employing this technology. Steam drying of bagasse is also a measure to increase the electrical power production (cogeneration). The gross calorific value of bagasse can be increased from 9000-10 000 kJ/kg (50% moisture) up to 18000-19600 kJ/kg. The boiler efficiency can be increased by up to 15% and the total electrical surplus power production by approx. 40-50 kWh/t cane. Impacts on the handling of dry bagasse, storage, boiler feeding and boiler design have to be considered and to be investigated further.

CO-PRODUCT

Comparative analysis of the main commercially available alcohol dehydration processes-azeotropic, extractive and molecular sieve-a technical and economical approach

A. Gomes Moura and A.C. Rocha D' Avila

THE MAIN commercially available processes for dehydration of alcohol, say, azeotropic, extractive and molecular sieve, present a number of characteristics such as plant sizes and quality of water or steam availability, which make them especially suitable for different situations. Besides, an important and differentiating characteristic of the process nowadays is its capacity of energetic interactions with other parts of the sugar and alcohol plant. Historically, in Brazil, extractive distillation using glycerine as dehydrating agent was largely used up to the 1 970s, but faced process limitations mainly due to glycerine viscosity. Then the process was successfully substituted by azeotropic distillation, based on benzene as dehydrating agent. The latter process had obvious hazards, and was adjusted to the use of cyclohexane in the 1980s. Worldwide, the application of the molecular sieve solution occurred at the same time. Recently, extractive distillation became a third commercial option, using a process with ethylene glycol as dehydrating agent. The present study has been developed with the intention to show, in a technical and economical approach, both the positive and negative points involving each of the referred processes. To do this, Dedini, as manufacturer of the three processes, collected data from plants worldwide, and submitted the data to a rigorous analysis of the following points: 1 - Steam consumption, considering source, price and availability. 2 - Water consumption and refrigeration, based on inlet and outlet temperature, and necessity of treatment. 3 - Possible undesired residues and recycles. 4 - Safety, health and environment. 5 - Capacity of energetic interactions with other parts of the sugar and alcohol plant. 6 - Plant size and initial investment. 7 - Automation required. The study concluded that each process has its optima in performance for different situations, as expected. As a general rule, the cyclohexane process is very suitable for small to middle plants of alcohol for fuel purposes and represents minimum investment. The extractive process based on ethylene glycol represents a good option as a middle-investment for anhydrous alcohol production containing a trace of the agent present in the product. Finally, the molecular sieve, whose anhydrous alcohol does not show any trace of the dehydrating agent, has the lowest steam consumption, but with a higher investment. The final choice will require more evaluation.

Techno-economical evaluation of diversification in the sugarcane industry

Juan Mario Gamarra , Electo Eduardo Silva Lara and Luiz Augusto Horta Noguelra

As A consequence of the continuous decrease in the sugar price, product diversification in the sugar industry, by the simultaneous production of energy, fuels, animal food and other by-products, is mandatory. In this paper, an optimisation program named 'Diversification' is developed and a case study is presented. For this case study, costs and prices were supplied by a medium-sized sugar and alcohol mill from the Minas Gerais State in Brazil. The optimisation program determines the optimal quantity of each product and by-product to be produced looking for a maximum specific profit (by tonne of milled cane). The set of products includes sugar, alcohol, molasses, surplus electricity and surplus bagasse. The Monte Carlo method was used for the investment risk evaluation. It is concluded that optimised diversification programs are economically justified and can lead to a considerable increase in the total specific profit of a sugar mill.

AGRICULTURE

Agronomy

Effect of phosphorus on physiological and agronomic parameters of sugarcane cultivars in Thailand

A. Sreewarome, B. Toomsan, V. Limplnuntana, P. Jaisil, Manjunatha S. Rao! Andm. Krishnamurthi

The effects of phosphorus (P) fertiliser on yield and quality of three sugarcane cultivars was evaluated in the upper northeastern region of Thailand. The study was conducted on a Roi Et series (fine-loamy, mixed, isohyperthermic Aeric Paleaquults) soil with three cultivars (K 90-112, K 86-161 and Phil 66-07) and four P levels (0, 72, 101 and 129 kg P2Os/ha). Application of P increased growth in terms of dry weight, crop growth rate, leaf area index, and height compared with the control (0 kg PzOs/ha). Phil 66-07 had the highest dry matter and crop growth rate in response to P application, followed by K 86-161. The rate of applied P did not influence nitrogen (N) and potassium (K) contents in various parts of the plant. Phosphorus content in the third leaf, green leaf, leaf sheath and phosphate in juice was higher when P was applied than in the control. At harvest, the higher P application increased both cane yield and stalk weight. Phil 66-07, at 129 kg PzOs/ha, produced the maximum growth, yield and quality. Yield and yield components of cane and sugar were lower in the control for all cultivars. Varietal differences did occur with the application of P fertiliser with Phil 66-07 being the most responsive. However, the application of 72 kg PzOs/ha was the optimum rate at which all cultivars gave superior response in terms of growth, yield and quality.

Potassium dynamics in Mexican sugarcane soils

Sergio Salgado Garcia, Gloria. Bolio Lopez, David J. Palma Lopez, Luz Del C. Lagunes-Espinoza And Mepivoseth Castelan Estrada

A POSSIBLE explanation for the variable response of sugarcane to the addition of potassium (K) was found by studying how the crop affects the content of soluble K (Ks), exchangeable K (Ke), non-exchangeable K (Kne), and buffer capacity (CK) after various times of cane cultivation. Three sugarcane plantations at Tabasco, Mexico with 10, 20, and 30 years of sugarcane cropping history in a fluvisol and a vertisol were compared to areas where sugarcane had never been grown. A composite sample of 100 kg of air-dried soil was collected from each location and blended and sieved before taking five, 250-g sub-samples from each soil. K was added to each subsample and incubated for 0, 1, 3, 7, 15, 30 and 60 days. Ks was extracted with 0.01 M CaCh, Ke with IN ammonium acetate at pH 7, and Kne with IN HNO3. Results showed that the decrease of K in its soluble and exchangeable forms, to the non-exchangeable form, was complete after 30 days of incubation. The vertisol showed a higher buffer capacity compared to the fluvisol. The Ks and Ke reserves were greater in the fluvisol compared with the vertisol. The fluvisol tended to accumulate more K throughout the years of cultivation compared with the vertisol which exhibited a decline in K status. This may be due to the lower clay content ,and shrink/swell properties of the clay in the fluvisol that will reduce K losses in the surface layer of the soil due to ash leaching, especially in fields with little or no slope. A better understanding of the K dynamics of soils from the sugar mill zone at Santa Rosalia, Tabasco, Mexico will facilitate improved diagnosis of K deficiencies and fertiliser recommendations for the soils in the milling zone.

Agriculture Engineering

Estimating costs of handling sugarcane trash for use as boiler fuel

Lg. Amu, C.O. Briceno, E. Moreno and A.L Gomez

The Colombian sugar industry is compelled by legislation to eliminate all burning of sugarcane prior to harvest by January 2005. Consequently, various strategies are being investigated to reduce the adverse impact of green-cane harvesting on the overall sugar production system. With green-cane harvesting, the large amount of biomass left in the field in Colombia creates agronomical difficulties that necessitate chopping the trash before leaving it on the ground, or removing it. Cenicana developed a special purpose attachment for a Claas-Jaguar 355 kW forage harvester which picks up the trash, chops it, and throws it directly into wagons that are hauled to the factory. Trials using trash for boiler combustion have been in progress since 1999. In order to have a smooth feed of biomass to the boilers, with the existing technology, it is necessary for the trash to be cut into pieces no bigger than 14 mm. These trials have been useful for technology refinement and possible projections. Monitoring of costs has been done, and a computer model (P ARCA) has been developed, based on cost allocation techniques, logistics, push and pull techniques, and queuing theory. Cost structures and computer model results using coefficients obtained during the trials are presented. The updated trash cost delivered to the factory is between US$5.29/t and US$6.64/t.

An investigation of the feeding characteristics of the forward-feeding zone of chopper harvesters: development of a research harvester

Rj. Davis and P. Norris

Current models of sugar cane chopper harvesters are affected by glut/starve situations for gathering and feeding of cane. The gathering system, including the forward-feeding zone (knockdown and finned rollers and the basecutters) and the setup of feed-train rollers, are areas indicated for improved performance. Alternative concepts were developed to improve the functionality of the gathering system and feed-train elements. However, there remains a lack of understanding of the interactions occurring between the machine components and cane in the forward-feeding zone during gathering, feeding, basecutting and buttlifting. The interaction of these components with the cane needs to be fully understood to address the issues of feeding, including minimum knockdown angle for butt-first feeding, control of cane for active feeding, and minimising dirt intake. A novel approach was developed to modify an existing harvester to allow alternative forward-feeding systems to be fitted and tested under identical conditions. Modifications to the front end allowed incorporation of any forward feeding layout by fitting a choice of specially manufactured modules. Two modules were developed, which incorporated leg and underslung basecutter configurations. Each module, when installed, allowed the harvester to be operated as a fully functional harvester. Evaluation of modules was supported by instrumentation, including high-speed cine film and data acquisition of loadings on components to characterise the flow of cane. Comparative trials under varying crop conditions benchmarked the flow of cane through the leg basecutter and underslung basecutter modules. The flexibility of the modular format enabled enhanced forward-feeding geometries to be evaluated and quantified using identical harvester extractor/chopper/extractor configurations. Importantly, the modules were fully evaluated in the field under commercial conditions. The functionality and performance of the harvester has demonstrated that the system is extremely flexible and offers a powerful research facility for evaluating the performance of harvester feeding systems worldwide.

Plant Breeding

Effect of ethephon on yield and sugar content of different sugarcane cultivars in Thailand

Manjunatha S. Rao, M. Krishnamurthi and Pipat Weeratha Worn

SEPARATE experiments were conducted to determine the effect of the growth regulator 'Ethephon' on germination and initial growth of four sugarcane cultivars (pot trial) and yield and sugar content of five sugarcane cultivars (field trial). The pot trial was replicated five times, with each replicated treatment containing 12 three-budded setts. The field trial was conducted using five Thai commercial cultivars with each planted in six rows x 5 m long, replicated thrice. Three concentrations of Ethephon (100, 250, and 400 mg/L) were used. Ethephon was sprayed when the plant cane was five months old. A plant and two ratoon crops were evaluated for the effect of treatment on yield and sugar content. Improved germination of treated plants was observed following treatment with 100 mg Ethephon/L resulting in increased germination in all cultivars (pot trial). Treatment resulted in increased lengths of shoots and roots. Increased fresh and dry weight in the treated setts also was observed. Differential response of the cultivars to the treatments was observed. Ethephon at 400 mglL significantly increased yield in aU cultivars except K 87-17 (plant cane) with a maximum of 83.06 t/ha in K 88-92. Positive response of sucrose accumulation to Ethephon in plant cane was seen with maximum effect at 400 ppm. Maximum increase of 2.5 units CCS was observed in variety K 84-69. Overall, on ratoon crops, Ethephon at 100 mg/L increased total sugar yield (K 86-161 recorded 10.13 t/ha in first ratoon and K 88-92 recorded 10.88 t/ha in second ratoon). Based on the present study, we found spraying Ethephon was beneficial in increasing CCS, cane, and sugar yield of sugarcane cultivars with 100 mg Ethephon/L producing the best effect.

Early sucrose accumulation, a promising characteristic to use in sugarcane improvement programs

A.R. Na Y Amuth, M. Mangar, K. Ramdoy Al and M.G.H. Badaloo

IN MAURITIUS, sucrose content of cultivars harvested during the early part of the season is sub-optimal due to a short ripening phase. Changes to the selection program and adoption of agronomic measures, such as artificial ripening, only partially solved the problem. The success recorded in other sugarcane industries on this aspect prompted basic studies. They were undertaken to understand the sucrose accumulation mechanism in parents, standards, and seedling populations to redefine breeding and selection strategies for producing cultivars with substantially higher levels of sucrose for earlier harvest. Physiological and cane quality characters were assessed during the exponential phase of growth at the age of seven months and at harvest early in the season at the age of eleven months. Statistically significant differences were recorded among parents and families, at the 99% level, for all characters irrespective of sampling date, and among standards, at the 95% level, in March only. Both significance level and variance were much higher during the growth phase. The best cane quality indicator, pol % cane dry matter, varied from 27.67% to 39.45% in the growth phase and from 50.39% and 54.84% at harvest for the families. Categorisation of the parents according to their pol % cane dry matter in the exponential phase of growth was a better indicator of their sucrose accumulation pattern and maturity behaviour than their sucrose content on a fresh weight basis at harvest. Three distinct maturity groups, early, mid/high sucrose and late were identified when considering sucrose accumulated during the growth

phase. The early group accumulated more than 75% of its harvestable sucrose percent cane dry matter at the age of 7 months as opposed to about 55% in the late group. This is a clear indication of the genetic control for earliness, as environmental conditions were not conducive to sucrose accumulation. Proposals for improving breeding and selection for earliness are categorisation of all parents for their sucrose accumulation pattern and maturity behaviour to enable a better choice, screening during the growth phase on pol % dry matter, and the adoption of appropriate standards or increasing the selection pressure.

Molecular Biology

Genomic analysis of transgenic sugarcane (Saccharum SPP.) populations: another link between biotechnology and breeding

Ariel D. Arencibia1, Maria T. Cornide, Elva Carmona, Stefano Castiglione and Francesco Sala

Different sources of somaclonal variation in transgenic sugarcane populations have been studied at the genomic level. AFLP analysis showed both polymorphic bands and variations in the relative intensity of the amplified DNA products within plants from the donor genotypes, providing molecular evidence of premmexisting variability in sugarcane. Genomic analysis of transgenic populations showed the presence of polymorphic bands among transgenic genotypes, as well as between in vitro plants without transformation and plants from the germplasm collection. Thus polymorph isms among transgenic lines can include pre existing variability, tissue culture induced variability, and the effect of the transgene insertions. Promising transgenic individuals for commercial use should be selected for transgene expression, the occurrence of DNA changes and the maintenance of desired phenotypic characteristics. The role of soma clonal variation in a sugarcane genetic engineering program is discussed, and a selection scheme, including genomic analysis, is suggested for genetic modified (GM) sugarcane plants.

Transgenic plants of cc 84-75 resistant to the virus associated with the sugarcane yellow leaf disease

M. P Aola Range, Lorena Gomez, Jorge. Victoria and Fernando Ange

THE virus associated with the yellow leaf disease of sugarcane (Sc YL V) was detected in Colombia in 1998. Since then it has been found in several commercial hybrids, especially in CC 84-75 which occupies second place in cultivated area in the Colombian sugar industry. Due to the susceptibility of most commercial hybrids and to the importance of CC 84-75, the possibility of producing transgenic plants with resistance to the virus was studied. Embryogenic callus of hybrid CC 84-75 was bombarded with plasmids pFM395 and pFM396 containing a ScYLV coat protein DNA fragment. After genetic in selection, 69 regenerates were obtained. Fifty-seven plants were positive for NPT II by PCR amplification. Forty-six plants out of 69 regenerates contained the coat protein coding fragment as confirmed by both PCR and Southern blot assays. Digestions with Barn HI, cutting only once within transgene, indicated the presence of six independent transformation events. Transformed plants were inoculated with Sc YL V by Melanaphis sacchari and tested for infection at monthly intervals, using TBIA and RT -PCR, for 10 months after challenge. Thirty-seven plants out of 66 tested negative for Sc YL V. A field test of resistant lines versus the original variety is underway.

Pathology

Effect of treatments to eliminate systemic athogens from sugarcane setts

Luis Guev Ara and Werner Ov Alle

TREATMENTS were evaluated for the elimination of systemic pathogens of sugarcane from one-budded setts. Two sugarcane varieties were used, CC84- 75 infected with Xanthomonas albilineans, the causal agent of leaf scald, and B69-613 infected with both Leifsonia xyli subsp. xy/i, the causal agent of ratoon stunting disease (RSD), and Sugarcane yellow leaf virus (SCYL V), the causal agent of yellow leaf. The following treatments were evaluated alone and in various combinations: hot water treatment (HWT; 3 h/50°C for X albUineans, and 30 min/52°C for 1. xyli subsp xyli and SCYL V), plantlet thermotherapy (PT, 3 weeks at 41 DC after planting into trays) and meristem tissue culture (MTC), together with an untreated control treatment. The final incidence of the pathogens after eight months of growth in the field was determined on a percentage of infected stalks basis by dot blot immunoassay for X albilineans and 1. xyli subsp. xyli and by tissue blot immunoassay for SCYL V. The combination of HWT, PT and MTC resulted in the lowest incidence of X albilineans (2% final incidence) and the other treatments gave similar degrees of control, compared with 80% for the untreated plants. Similarly, the combined use of HWT, PT and MTC resulted in the lowest incidence of SCYL V, 19%, compared with 78% for the untreated plants. For 1. xyli subsp. xyli, all treatments eliminated the causal agent completely, whereas there was a 97% incidence in the untreated plants. The mean effect of treatments to control RSD and SCYL V in variety B69-613 was to increase cane yield by 27%. There was some evidence of a depressing effect of SCYL V on sugarcane yield.

Efficient tool for managing the sugarcane qurantine in Cuba: cuarent for windows version

Ra Francia, I.M. Jorge Gomez and G. Galvez Rodriguez

NT for Windows version 2.5, based on advanced-computational techniques, is presented for control of quarantine information and progress of foreign sugarcane varieties in the qurantine program in Cuba. This software gives services to researchers and technicians Sugarcane Genetic Improvement Program and offers the following possibilities: Ice for describing some physical characters of foreign genetic material in the house and field trials; database-management of the passport information of modem varieties, including original forms and parental information; and a record of diagnostic, sanitary and agronomic observations. The program allows decisions to be made about the geographic destination of the foreign material, to determine the adequate diagnostic tool evaluating sanitary quality before release, and offers some general criteria about the commercial and/or genetic value of individuals arriving into the country.

Entomology

Effect of armyworms mythimna spp. (lepidoptera: noctuidae) on cane growth in Mauritius

S. Ganeshan

An upsurge in the population of armyworms causing defoliation of young regrowth of machine-harvested sugarcane fields has been observed since 1992. Every year, about 15% of the area harvested mechanically is damaged. Due to the suddenness and the spectacular nature of the damage (total defoliation within a few days), growers often resort to insecticides to control the pest. The effect of defoliation on cane growth and the need for insecticide applications were assessed. Results indicate that fields damaged prior to October could recover from the damage, and no significant reduction in growth or tillering was observed. Fields damaged after October did not recover, and up to 16% reduction in cane height was observed in totally defoliated plots. No significant difference in cane height or tiller density was observed in the two damage simulation trials which were established in September. These results indicate that insecticide treatment is not warranted when infestations by armyworms occur before October. Later infestations should be treated to avoid cane growth reduction.

Preparedness for borer incursion: an Australian experience

Mohamed N. Sallam1 and Peter G. Allsopp2

Moth borers are the most devastating pests of sugarcane, but Australia is free of any significant species. Given that several species occur in countries close to Australia, this project aimed to increase Australia's preparedness for an incursion of an exotic borer. We developed Incursion Management Plans specific to each borer genus that detail the steps to be taken in case of a borer incursion, and include extensive dossiers on each species with information on their distribution, host plants, symptoms, economic impact, morphology, detection methods, biology and ecology, natural enemies, management options and phytosanitary risk. To speed up the identification process in the event of an exotic pest incursion, DNA. based identification methodology was developed; this will reduce the time required to identify a borer. We tested pheromone traps in 10 sites across Queensland and the Torres Strait to determine their usefulness for early warning of incursions. A list of about 800 records of parasitoids, predators and pathogens of the 24 key moth borers in Asia and the Indian Ocean islands was compiled, with information on the host stage they attack, host plant or crop and country of record. This information will facilitate rapid decision. making regarding importation of a suitable natural enemy. No insecticides can yet be registered in Australia against borers, but two insecticides, tebufenozide and lambda.cyhalothrin, which could be used in Australia against an introduced borer, were identified. Finally we tested responses by simulating an incursion. A major outcome of this project is the current wide awareness of the threat posed by exotic borer§ to Australia.

INSTRUCTIONS FOR AUTHORS

Dear Authors,

Please follow these instructions for review/publication of your research papers in PAKISTAN SUGAR JOURNAL (PSJ). It will help editorial board to review your articles immediately. Otherwise, it will be delay in review process:

- Write the title of your article in CAPITAL LETTERS in the center of the page
- Write the complete name of all authors with their addresses, its compulsory
- In the text, references should be cited by author and years as, for one, two or more authors (Hammer, 1994, Hammer and Rouf, 1995; Hammer etal., 1993), respectively.
- Write HEADINGS in bold letters and in the center of the page.
- Type your article only in TIMES NEW ROMAN format.
- Send TABLES or FIGURES on separate page with bold title and mark its numbers correctly.
- Follow the following rule for Reference, for one author: Hussain, K. 1991 for two authors; Khan, M. and A. Habib 1995, for more than two; Ali, K., A. Hussain and S. Nasir. 1990
- Don't write the 3 name of journals in ITELICS In Reference.
- Always send tow soft copies and one hard copy of CD. Please don't use FLOPPY for this purpose
- Send copies on A-4 size page preferable LASER PRINT in word document
- PSJ publishes paper free of charges from authors