Pak. J. Biotechnol. Vol. 21(2),457-462, ***2024.*** http://doi.org/10.34016/pjbt.2024.21.02.949

Research Article

OPEN ACCESS

Available on http://www.pjbt.org
Pakistan Journal of Biotechnology (PJBT)
(P-ISSN: 1812-1837 and E-ISSN: 2312-7791)

PERFORMANCE EVALUATION OF SUGARCANE CLONES AT PRELIMINARY YIELD TRIAL

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Article Received 05-03-2024, Article Revised 07-06-2024, Article Accepted 01-08-2024.

ABSTRACT

In the current study, fifteen (15) sugarcane clones developed from Sri Lanka and Barbados fuzz were evaluated for quantitative and qualitative traits in local set of climatic conditions. After testing and advancement from early stages of sugarcane cultivar development program, these clones were planted in 4th stage i.e. preliminary yield trial to evaluate the performance of clones in comparison to two local check varieties *viz.* CPF 253 and HSF 240. The testing sugarcane clones along with check varieties were planted in a randomized complete block design (RCBD) deploying three replications during the crop season 2022-23. Biometric parameters like germination (%), plant population, plant height, 10-cane weight, cane weight and cane yield alongwith sugar recovery were studied. The biometric traits were compared using two-sided Dunnett's multiple to check the level of significance. The results showed high level of significance for all the biometric traits. The clone BDF-20-174 showed superior performance for plant population, cane yield and sugar recovery as compared to local check varieties. Similarly some other clones surpass the check varieties in some traits but their overall performance remained at par or lower than check varieties. However, further testing and experimentation will be applied to pick more adapted and suitable clones for local agro-ecological conditions.

Key words: Sugarcane, fuzz, Sri Lanka, Barbados, adaptability, sugar yield, sugar recovery

INTRODUCTION

Sugarcane (*Saccharum* spp.) is one of the most important cash crop that is contributing 75% of world sugar production (Wang *et al.*, 2010) and it is commercially cultivated mostly in Brazil, India, Pakistan, China, Thailand, USA, Mexico, West Indies and Australia. By occupying a valuable position in global trade and world economy, sugarcane is an important crop for food commodity and also used as a valuable industrial and bioenergy source (Oliveira *et al.*, 2005).

In Pakistan, sugarcane is the 2nd largest cash crop of the country, having a share of 0.8% in GDP and 3.5% in agriculture value addition. During 2023-2024, sugarcane crop was cultivated on an area of 1.20 million ha with production of 87.6 million tones. The overall production was slightly declined to 0.4 percent over the last year (Govt. of Pakistan, 2023-24). During 2023-24, there was an encouraging yield increase of 11.5% over the last year (Crop Reporting Service, 2023-24), that might be due to high varietal potential under favorable climatic conditions alongwith better return to growers during last year.

Being a long duration crop, presence of wide adaptability characters in various growing zones, sugarcane crop needs more attention to fulfill world sugar and energy demand of ever increasing world population under the current and future alarming threats of climate change. It has been frequently reported that climate change is increasing the threats of lodging, incidence of insects pest attack and different disease pathogens that ultimately results in negative impacts on growth, yield and sugar recovery of sugarcane crop. Under these circumstances the scope for breeding in sugarcane crop is to enhance a broader genetic base and to improve productivity and adaptability of future varieties. The researches needs to be focused on well adapted, resistant and site specific varieties to be cultivated in various ecological zones. The weather and climatic factors plays a vital role in sugarcane production because it is reported as quite sensitive crop for any slight variation in temperature, and rainfall etc (Zhao and Li, 2015). Selecting parents with desired traits is very important in developing a new variety. Quantitative characters such as yield is directly linked with climatic conditions (Pandey *et al*. 2018). By introducing new cultivars adaptability of selected clones needs to be evaluated well in various climatic zones for its suitable and successful cultivation.

For developing a new variety, its genetic variability is having key importance for a breeder during selection. Distinctness, uniformity and stability of characters are recorded during the varietal approval phases of cultivar development program. In sugarcane crop, usually two sources of genetic variability are used i.e. crossing of diverse and desirable parents to get fuzz and import of sugarcane setts directly from other countries, known as direct introduction. The targeted breeding program is only to find out improved, well adapted and resistant sugarcane clones having good sugar recovery and cane yield to get profitable sugarcane cultivation by the growers and cane processors (Jackson, 2005).

The objective of present study is to check performance and adaptability of different sugarcane clones developed from fuzz of two origin i.e, Sri Lanka and Barbados in comparison to local check varieties, HSF 240 and CPF 253. The selected sugarcane clones that show better adaptability in local climatic conditions will be tested further in next stages of sugarcane cultivar development program to find out better clone(s) to be approved as commercial variety.

MATERIALS & METHODS

Description of experimental site: The evaluation of fifteen (15) sugarcane clones was undertaken in Nursery-III; fourth stage of cultivar development program in 2022-23 at research farm of Sugarcane Research Institute (SRI), Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan. The soil was loamy in texture with electric conductivity (EC) 1.62, pH 8.4, organic matter 0.91%, available phosphorous 9.4 ppm, available potassium 194 ppm and saturation 37%. The data on various weather attributes was collected from the observatory of Agronomic Research Institute, AARI, Faisalabad and in given in table 1.

Table. 1. Weather data for sugarcane crop cycle (2022-23)

Month	Mean max. temperature	Mean min. temperature (°C)	Mean relative humidity (%) at 5 pm	Total rainfall (mm)
October	34.1	19.2	47.2	34.4
November	28.2	12.4	51.3	4
December	21.8	7.4	58.9	2.3
January	18.4	4.8	55.9	30.7
February	26.1	10.7	42.6	6.4
March	28.1	14.4	56.7	55.2
April	33.5	18.4	43.8	42.2
May	36.2	22.7	43.2	34.3
June	38.0	26.2	53.6	39.4
July	35.6	27.2	71.3	114.2
August	38.2	28.4	60.50	16.0
September	36.3	25.6	63.5	116.6
October	32.5	19.1	58.1	25.0
November	26.4	13.7	62.7	4.2
December	22.5	7.6	60.0	0.0

Experimental details and crop husbandry: The trial was planned on October 4, 2022 in a randomized complete block design (RCBD) replicated thrice (03). Uniform seed beds were prepared by using standard operations to ensure planting of crop at four feet dual row trench planting method. Plot size was maintained as 3.60 m × 4.00 m and triple budded setts/billets (TBS) were planted in each plot by ensuring recommended and uniform seed rate of 50000 TBS/ha. Recommended fertilizers @ 168:112:112 NPK kg/ha was applied in the form of urea, diammonium phosphate (DAP) and sulphate of potash (SOP). Whole DAP along with half dose of SOP was applied at planting in the trenches and urea was applied in three equal splits *viz.* at 50, 75, 100 days after planting (DAP). The setts were covered with thin layer of soil after sowing and light soaking irrigation was applied. First three light irrigations were applied to allow better sprouting of seed setts and overall 18 irrigations were supplemented during whole crop cycle in addition to rainfall. Second dose of SOP was applied at 100 DAP at the time of earthing up of crop. All other recommended management practices were applied uniformly to all experimental plots. The crop was harvested after 14 months and all the parameters (except Germination %) were recorded at maturity. All the parameters of tested clones were compared against check varieties HSF 240 and CPF 253.

Following sugarcane clones raised from fuzz of the Sri Lanka and Barbados were tested against the check varieties *viz.* HSF 240 and CPF 253 (Table 2).

Table 2. Sugarcane clones under experimentation

Origin of fuzz	Varieties
Sri Lanka (08)	SLF-20-01, SLF-20-41, SLF-20-47, SLF-20-59, SLF-20-69, SLF-20-70, SLF-20-101, SLF-20-105
Barbados (07)	BDF-20-109, BDF-20-113, BDF-20-124, BDF-20-130, BDF-20-173, BDF-20-174, BDF-20-178
Check varieties	CPF 253 & HSF 240

Recording of biometric and qualitative traits: Sprouting data was recorded at 50 DAP and thereafter both were converted into germination%. Plant population, plant height, 10-cane weight, single cane weight, cane yield and sugar recovery/commercial cane sugar (CCS%) were computed at harvesting on achieving crop age of 14 months. All the data were recorded by following standard procedure and techniques. For plant population, all mature canes of each experimental unit were recorded to find out millable canes per acre. Plant height was measured by using a meter rod on 10 randomly selected stalks from each experimental unit, and the measurements were then averaged. Whole of each experimental plot was harvested and after removing tops and trash, stripped cane weight was carried out through floor balance to work out cane yield in munds per acre. For quality analysis of cane juice, ten randomly selected stripped canes of each experimental unit were brought to the Sugarcane Technology Laboratory, SRI, Faisalabad where they were crushed by using electric cane crusher (with 70% extraction) to extract juice. Hydrometer with temperature of 20°C standardization were used to notice brix% and Pol% were worked out with Horn's dry lead sub-acetate method of sucrose analysis (Anonymous, 1970). Following formula was employed to calculate CCS% and then it was multiplied with 0.94 to find out sugar recovery:

$$CCS\% = 3P/2\ \{1-(F+5)/100\}-B/2\ \{1-(F+3)/100\}$$

(P stands for pol%, F for fibre% and B for Brix%)

Statistical Analysis: The collected data was tabulated, summarized in Microsoft Excel sheet and then data collected was subjected to Statistix 8.1 software for its statistical analysis (MacGraw-Hill, 2008). Moreover, the significance of the performance of clones was checked by using Two-sided Dunnett's Multiple Comparisons. The sugar recovery and yield is also presented graphically.

RESULTS AND DISCUSSION

During current research experimentation, 15 clones were evaluated against two local check varieties. The clones consisted of two origins, 07 from Barbados and 08 from Sri Lankan fuzz tested at Sugarcane Research Institute, Faisalabad. The results are presented in table 3.

Table. 3 Performance of 15 Clones in comparison with Two Check Varieties

Clone Names	Germination (%)	Plant Population/ acre	Plant Height (cm)	10-cane wt (kg)	Single Cane wt (kg)	Sugar Recovery (%)	Cane yield (maund /acre)
BDF-20-109	36.0	17685	220	13.3	1.33	12.50	587
BDF-20-113	48.0	21019	195	12.5	1.25	11.40	681
BDF-20-124	39.3	16852	226	16.2*	1.62*	12.57	672
BDF-20-130	33.0	30093	230	13.1	1.31	12.07	995
BDF-20-173	50.3*	34907	262*	15.6*	1.56*	11.50	1367*
BDF-20-174	38.0	41667**	236	13.2	1.32	12.97*	1345*
BDF-20-178	34.0	32593	236	13.3	1.33	12.57	1083
SLF-20-01	37.7	33333	264*	13.2	1.32	11.29	1096
SLF-20-41	35.7	17685	186	9.3	0.93	11.07	415
SLF-20-47	38.3	23426	213	10.4	1.04	13.03*	602
SLF-20-59	30.7	27315	231	14.1	1.41	12.27	971
SLF-20-69	38.0	31204	241	13.1	1.31	11.93	1020
SLF-20-70	36.7	32778	217	14.4*	1.44*	12.00	1197*
SLF-20-101	35.0	30370	229	11.0	1.10	12.07	836
SLF-20-105	33.3	33241	247	12.6	1.26	12.47	1045
HSF 240 (C)	36.7	34352	242	10.5	1.05	12.97*	974
CPF 253 (C)	48.0*	29352	247	13.9	1.39	12.20	1017
CV	CV 5.61	13.24	9.50	16.47	16.49	6.70	21.92
SEM	1.21	2193.1	12.65	3.23	0.323	0.47	117
SED	1.72	6101	17.90	3.73	0.374	0.66	166

**=significant, CV=coefficient of variation, SEM=standard error of mean, SED=standard error of difference*

Both germination and plant population are interrelated factors that significantly impact the yield of sugarcane. Effective germination ensures a uniform and healthy crop stand, while an optimal plant population maximizes resource use and encourages productive growth. Together, they are key components in achieving high sugarcane yields. The germination (%) of BDF-20-173 was significantly higher that the HSF 240 that was followed by CPF 253. No other clone could surpass the check varieties for this trait. Plant population of BDF-20-174 stood 41667 per acre which is significantly higher that both check varieties. It is worth mentioning that the germination (%) of BDF-20-174 was less than BDF-20-173 but its plant population exceeds significantly that shows its better tillering capacity after germination. Similarly in case of check varieties, germination% of CPF 253 was significantly higher than HSF 240 but the plant population of HSF 240 was greater than CPF 253, showing its better potential for making more tillers. The germination (%) and tillering capacity of each clone determine the seed rate of that clone at the time of varietal approval. Jain *et al*. 2006 has reported less than 40 % germination of cane setts in subtropical region. The germination (%) is usually high in tropical regions of the world. Current study depicted the range of germination from 30.7 to 50.3%. Number of canes per unit area are more important to determine sugarcane crop yield so, it is considered more importance to make indirect selection to target sugarcane yield (Milligan *et al*., 1996; Gravois *et al*., 1991), In case of plant height, two clones BDF-20-173(262) and SLF-20-01 (264) were better than check varieties HSF 240 (242) and CPF 253 (247). The weight of 10 stalks of BDF-20-124 (16.2), BDF-20-173 (15.6) and SLF-20-70 (14.4) was significantly higher than HSF 240 (10.5).

The next trait of single cane weight was compared and it was found that three clones naming BDF-20-124 (1.62), BDF-20-173 (1.56) and SLF-20-70 (1.44) were significantly higher than the check varieties HSF 240 (1.05). The amount of recoverable sugar was significantly higher in BDF-20-174 (12.97), SLF-20-47(13.03) and HSF 240 (12.97) while the sugar recovery of remaining clones was at par or lower than either of check varieties (Table 3 and Figure 1). Table 3 and Figure 2 reveals that the comparison for cane yield with check varieties showed that BDF-20-173 (1367), BDF-20-174 (1345) and SLF-20-70 (1197) maunds/acre have higher values. Some other clones also depicted better performance in case of cane yield but remained at par with check varieties.

Current experiments showed variation among clones developed from fuzz of Barbados and Sri Lanka in comparison to local check varieties HSF 240 and CPF 253 for main biometric and qualitative parameters. These differences may be attributed to the ability of different genetic make-up to adapt in different climatic conditions to produce variable response for given traits. Capability of a clone to produce more sugar and yield shows its level of adaptability for specific climatic conditions (Panwar *et al*. 2022). The clones that have better genetic makeup shows better ability to perform better under specific climatic conditions (Arain *et al*., 2011). Genetic make-up of a clone plays key role for its better performance as all the cultural and growing conditions are effective in the presence of improve genetic makeup (Ahmad *et al*. 2022; El-Geddaway, *et al*. 2002; Keerio *et al*, 2003). Mahmood-Ul-Hassan *et al.* (2020) also depicted different response of sugarcane for quantitative and qualitative traits for a set of climatic conditions with better genetic makeup. Favorable conditions related to climate and crop handling during the cropping season bear better results of a clone (Afghan *et al*., 2013). The clones that produce more germinant and tillers in early stage of crop and high number of millable canes during harvest stage of crop are considered more productive (Arain *et al*., 2011; Khan *et al*., 2003; Javed *et al*., 2002). A clone that gives good germination followed by high tillering capacity alongwith higher number of millable canes is the key criteria to check the performance of agronomic traits of clone (Sharma and Agarwal, 1985). The clones that show significantly lower yield of agronomic parameters have low performance (Arain *et al*., 2011). Havier cane stalk and comparable cane yield without losing the economic profitability of the cultivar can be fruitful while making effective decision for selection of clone (Islam *et al*, 2024)

In present research experimentation the attempts were made to find out best suited clones for local climatic conditions. The clone BDF 20-73 was outstanding in cane yield and sugar recovery in current evaluation. However, further experimentation in advance stages of cultivar development program will decide its fate to be picked as future candidate variety.

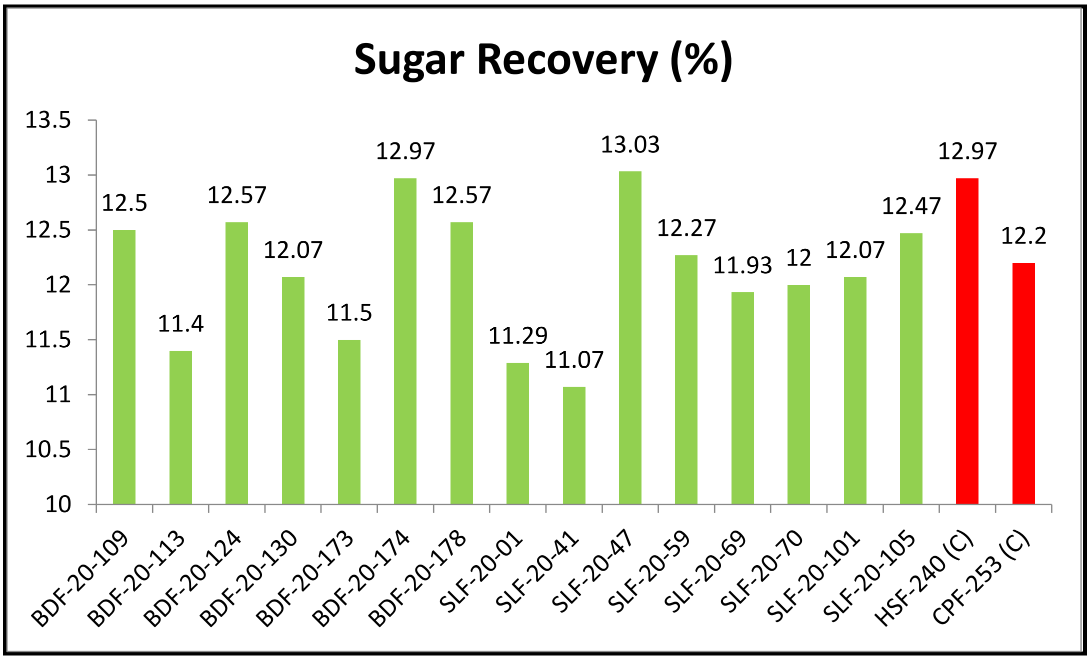

Figure 1. Comparison of clones for Sugar Recovery (%)

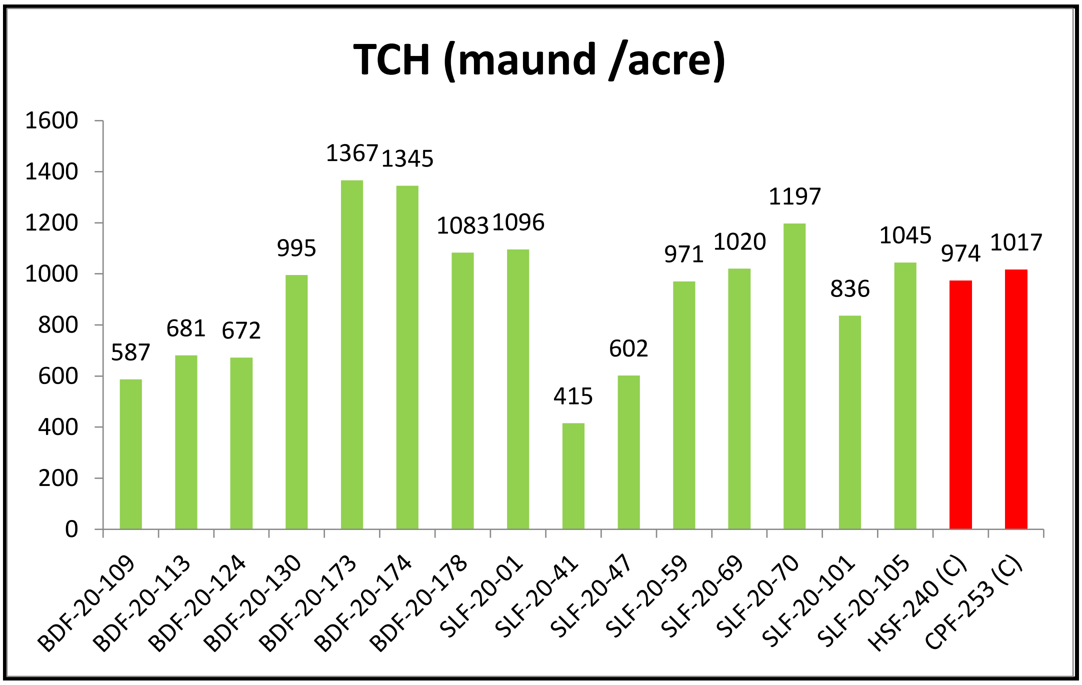

Figure. 2. Comparison of clones for TCH (Maunds/acre)
*****Tons of canes per hectare*

CONCLUSION

The sugarcane cultivar development program of Sugarcane Research Institute, Faisalabad focus on exploiting the genetic variability of fuzz crosses in most of cases for testing, selection and advancement of clones to develop genetically improved varieties. In current studies, fifteen (15) sugarcane clones developed from Sri Lanka and Barbados fuzz were evaluated for agronomic and qualitative traits in local agro-ecological conditions against two local check varieties (HSF 240 & CPF 253). Although few clones under experimentation showed better performance for agronomic traits but the performance of BDF-20-174 is matchless in conjunction plant population, cane yield and sugar recovery as compared to all others including local check varieties. The performance of these clones in next stage of cultivar development program will decide their fate to be selected as candidate clone for future.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Sugarcane Research Institute (SRI) in Faisalabad for providing the opportunity to conduct this research. We also extend our heartfelt thanks to our support staff for their invaluable assistance throughout the process. Additionally, we are grateful to the Sugarcane Research & Development Board

(SRDB), Punjab, for funding the research project that made the publication of this manuscript possible.

AUTHORS CONTRIBUTION

M.S. Afzal, M.U. Hassan, and H.B. Ahmad conducted the research, collected and analyzed the data, and wrote the manuscript. B.H. Babar, M. Yasin, and R. Naheed assisted in writing the manuscript, while M. Zafar provided guidance to the entire team.

FUNDING

The SRI, Faisalabad provided funding for conducting the research, while the publication fees were covered by the SRDB-funded project titled "Establishment and Strengthening of Nursery Shed for Raising Sugarcane Seedlings at SRI, Faisalabad."

AUTHORS CONFLICT

The authors declare that they have no conflicts of interest.

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