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Evaluation and Final Selection of Sugarcane Clones Based on Biometric Performance and Qualitative Characteristics

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Abstract

Eleven sugarcane clones, including two check varieties, were evaluated under field conditions to assess agronomic traits and sugar recovery for commercial selection. Clone SLF 18-92 produced the most tillers but was rejected due to lodging and lower recovery. SLF 18-743 produced the highest cane yield (111 t/ha), while SLF 18-748 yielded 108 t/ha. The maximum sugar recovery was recorded in SL-41 (12.63%), followed by SLF-569 (11.94%). Conversely, SL-83 was rejected due to poor yield (82 t/ha) and disease susceptibility. Ultimately, SL-41 was promoted for commercial cultivation due to its superior sugar recovery and adequate yield. Meanwhile, clones SLF-569, SLF 18-743, SLF-661, and SLF 18-748 were retained for further trial evaluation. This study underscores the necessity of multi-trait evaluation for selecting high-performing sugarcane clones adapted to local conditions.

Keywords: Germination, Sugar recovery, Millable canes, Sugar Yield
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Introduction

Sugarcane (*Saccharum officinarum* L.) is a foremost commercial crop grown primarily for sugar production and is a major contributor to Pakistan's agro-based economy. It accounts for about 3.4% of the value added in agriculture and 0.7% of GDP (GOP, 2023). The sugar industry has faced multiple challenges in recent years, including declining sugar recovery, lower yield potential of current varieties, climate unpredictability, and evolving biotic and abiotic stresses. The continuous screening and selection of new high-performing sugarcane clones/varieties are crucial to address these limitations and safeguard sustainable production (Majeed et al., 2023). The development of higher-quality sugarcane varieties involves multi-year testing of clones at different stages across multiple locations for agronomic and juice-quality traits (Majeed et al., 2024). Key parameters such as millable cane production, germination, cane yield, tillering ability, and sugar recovery percentage of a clone are used to assess its commercial feasibility (Hussain et al., 2020). Equally essential are resistance to diseases such as red rot (Colletotrichum falcatum), lodging tolerance, and adaptability to agro-climatic environments. Only those clones that meet the preferred criteria in both cane yield and quality traits are chosen for further multiplication and release as commercial varieties. Final selection varietal trials play a critical role in the varietal development process. This procedure confirms that only superior clones with constant performance across environments are presented to the farming community (Nazir et al., 2019). The present study was undertaken to evaluate selected sugarcane clones at the final selection stage. The objective of the present study was to identify and promote high-sugar-recovery and high-cane-yielding clones with the required agronomic attributes and resistance to major diseases. The outcomes of this study will contribute to the varietal development program by improving sugar production and establishing the genetic base of sugarcane germplasm.

Materials and Methods

The present experiment was conducted in the research fields of the Sugarcane Research Institute, Faisalabad, during the final selection trial of promising sugarcane clones in the 2023–24 cropping period. Eleven sugarcane clones with two standards checks (HSF-240 and CPF-253) were assessed for their plant growth, cane yield, and qualitative features. The experiment was laid out in a randomized complete block design with three replications, having a net plot size of 4×8.4m. Recommended agronomic practices for the sugarcane crop, including land preparation, irrigation, fertilization, earthing up, and pest and disease control, were consistently followed across all plots (Majeed et al., 2022). Germination percentage data were recorded after 45 days of planting, while numbers of tillers per plant were counted at 90 days. Sugarcane yield and number of millable cane count was recorded by harvesting the central two rows of every plot. Juice quality analysis to determine the sugar recovery percentage for each clone was carried out at 10 time points, from November 2023 to March 2024. For each clone sampling, 10 sugarcane stalks per plot were randomly selected and crushed using a sugarcane crusher. Brix and pol readings of juice were taken using a hydrometer and a polarimeter, respectively, to calculate sugar recovery percentage (Chen & Chou, 1993; Meade & Chen, 1977). The data were statistically analyzed using analysis of variance, and treatment means were compared using the Least Significant Difference (LSD) test at a 5% probability level, as described

by Steel et al. (1997). Based on the outcomes, the clones were rejected, promoted, or retained according to their performance in both qualitative and agronomic traits.

Results and Discussion

The screening of eleven sugarcane clones, including two approved varieties as checks (HSF-240 and CPF-253), during the 2023–24 cropping season revealed significant differences in agronomic and qualitative characters, which are critical for selecting superior clones for variety approval and commercial cultivation. Among the agronomic attributes, germination percentages ranged from 32.5% to 55.1% (Table 1), with variety CPF-253 showing the highest (55.1%), followed by clones SLF-569 (51.3%) and SLF-18-743 (49.5%). In contrast, the clone SLF-661 exhibited the lowest germination rate (32.5%), which may be attributed to either genetic constraints or seed viability issues. A well-established crop position is essential in sugarcane production, as lower germination directly affects tillering and sugarcane yield (Majeed et al., 2022; Hussain et al., 2020). Tillering ability of sugarcane clones varied significantly (Table 1), with SLF-18-92 producing the highest number of tillers per plant (1.44), followed by clone SLF-18-748 (1.07) and SLF-18-743 (1.06). Despite its higher tillering ability, clone SLF-18-92 was rejected due to poor stalk development, lodging susceptibility, and lower sugar recovery. This emphasized the significance of considering stalk juice quality along with tillering capability of sugarcane clones in the varietal approval process (Majeed et al., 2022; Nazir et al., 2019). The number of millable canes, which is a direct contributor to sugarcane yield, ranged from 56,000 to 122,000 canes per hectare (Table 1). The sugarcane clones SLF-18-92 and HSF-240 recorded the maximum values; however, the clone FG-09-190 showed the lowest value (56,000/ha), which was associated with an inferior crop stand and poor germination.

Table 1. Evaluation and final selection of sugarcane clones based on plant growth attributes

Sugarcane clones	Germination (%)	Tillers per plant	Millable cane (000/ha)	Cane yield (t/ha)	Remarks
S-2016 SL-41	46.9abc	0.95bcd	98c	100ab	Promoted
S-2016 SL-83	38.3de	1.21ab	84d	82c	Rejected due to low cane yield & red rot susceptibility
SLF-18-92	35.2de	1.44a	122a	99b	Rejected due to thin stalk, high lodging & low sugar contents
PSR-08-38	41.8cd	0.63d	83d	85de	Rejected due to poor stand, low cane yield, lodging, low sugar contents & red rot susceptibility
FG-09-190	41.3cd	0.64d	56e	53.3d	Rejected due to poor stand and low cane yield
SLF-661	32.5e	0.65d	69e	75c	Retained

SLF-18-743	49.5abc	1.06bc	101c	111a	Retained
SLF-18-748	47.4abc	1.07bc	104bc	108ab	Retained
2018-SLF-569	51.3ab	0.82cd	101c	99b	Retained
CPF -253	55.1a	0.84cd	84d	98.3b	Check
HSF -240	46.6bc	1.11abc	115ab	105ab	Check
LSD Value	8.32	0.35	13.4	11.3	

Cane yield is an accumulative consideration of all agronomic attributes. The maximum cane yield was noted in SLF-18-743 (111 t/ha) followed by SLF-18-748 (108 t/ha) and HSF-240 (105 t/ha). In contrast, the clones FG-09-190 and SL-83 produced cane yields of only 53.3 t/ha and 82 t/ha, respectively, and were therefore rejected (Table 1). The sugarcane clone SL-41 produced a good yield of 100 t/ha, exhibited adequate agronomic traits, and was recommended for promotion. These outcomes are similar to those reported by Khan et al. (2017), who highlighted that clones with high-yielding potential must also exhibit stability and resistance to ecological and biological stresses. Juice quality analysis of all sugarcane clones revealed significant differences in sugar recovery% among the clones throughout the crushing period. The average sugar recovery% of clones ranged from 10.69% to 12.63% (Fig. 1).

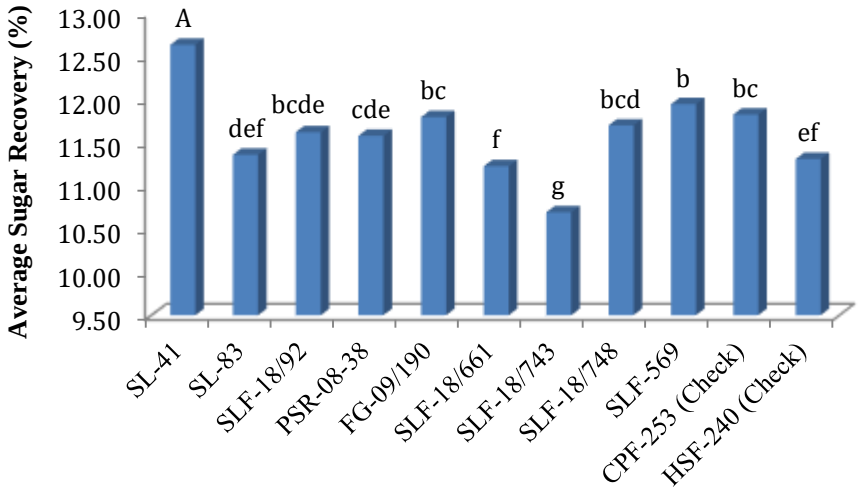

Figure 1. Average sugar recovery (%) of all sugarcane clones.

The clone SL-41 showed the highest average sugar recovery (12.63%), followed by clone SLF-569 (11.94%), CPF-253 (11.83%), and FG-09-190 (11.80%). The increase in sugar recovery ratio over time indicated plant physiological maturity (Fig. 2) and the sucrose accumulation trends typically observed in the sugarcane crop (Majeed et al., 2024, Javaid et al., 2021). However, the clone SLF-18-743 recorded the maximum cane yield (Table 1). Still, its sugar recovery (10.69%) remained comparatively low, representing that higher biomass alone is not enough for varietal elevation unless linked with good juice quality and sugar recovery (Zafar et al., 2025; Majeed et al., 2023). SLF 18-748 and SLF-

569 exhibited a balanced performance, with better sugarcane yield (108 t/ha and 99 t/ha, respectively) and adequate sugar recovery (11.70% and 11.94%), making them appropriate candidates for retaining and further evaluation (Fig. 2). Clones such as SL-83 and PSR-08-38 were rejected due to low cane yield, poor sugar content, lodging and red rot vulnerability (Table. 1). The clone SLF-661, regardless of low germination and can yield, was retained due to reasonable sugar content and potential for improvement in further research trials. These outcomes are consistent with Bhutto et al. (2022), who suggested selecting based on multi-trait performance rather than relying on a single attribute.

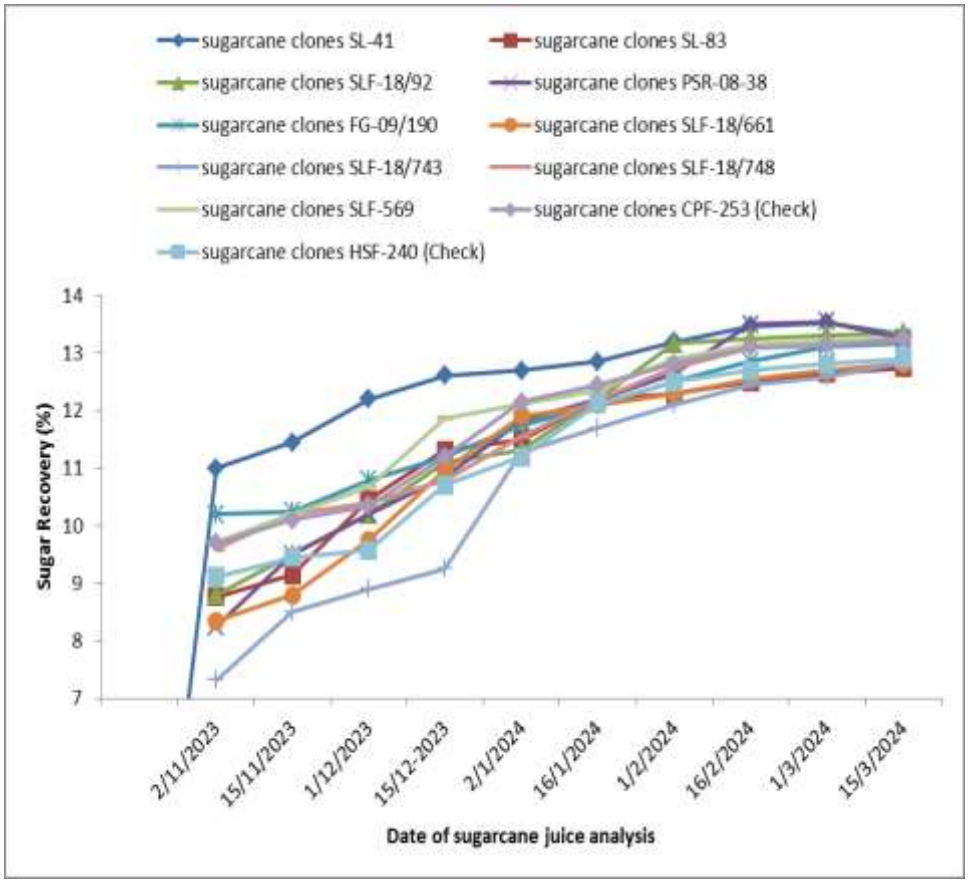

Figure 2. Periodic sugar recovery (%) over time of all sugarcane clones

In conclusion, the outcomes indicate that the sugarcane clone SL-41 has strong potential for varietal release due to its high sugar recovery and stable plant growth performance. The sugarcane clones SLF-18-743, SLF-18-748, SLF-661 and SLF-569 were retained for further evaluation in research trials due to their generally hopeful results. The combination of biometric data and juice quality attributes proved effective for screening sugarcane

clones, confirming that only well-rounded genotypes proceed in the breeding and varietal development process.

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