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Research Article

Assessment of promising sugarcane clones for yield and juice quality attributes at final selection stage

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ABSTRACT

Sugarcane is a major cash crop of Pakistan, grown for sugar, jaggery, and by-products such as ethanol, molasses, and bagasse, and it plays a significant role in the national economy of Pakistan. In order to evaluate the agronomic and sugar recovery percentage of promising sugarcane clones for their selection at final stage and commercial cultivation; ten sugarcane genotypes/clones were evaluated for agronomic performance and sugar recovery percentage over various harvesting dates during crushing seasons. Significant dissimilarity was noted among genotypes for tillers per plant, germination percentage, millable cane population, sugarcane yield and juice quality characters. Data depicted that the germination percentage and sugarcane yield was ranged from 20.9 to 55.5% and 62.3 and 108.7 t ha⁻¹ respectively across all genotypes. Average sugar recovery percentage over sampling dates ranged from 12.05 (S2015-SL-444) to 12.68 percent (S2013-US-917). Based on pooled assessment the two genotypes specifically S2015-SL-89 and S2015-SL-289 were retained due to a satisfactory balance of cane yield and juice quality, while the other cane genotypes were rejected due to one or more limiting factors such as low sucrose content, poor crop stand, lodging, low cane yield, red rot susceptibility and cane brittleness. The findings indicate the importance of integrating both crop quantitative yield components and juice quality parameters in final selection stages of breeding programs for commercial sugarcane cultivation.

Keywords: Sugarcane genotypes; sugar recovery; millable canes; clone selection.



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INTRODUCTION

Sugarcane is one of the most important cash crops of Pakistan, cultivated mainly for sugar production, jaggery and a variety of by-products such as ethanol, molasses and bagasse (Nazir et al., 2020). Sugarcane crop contributes considerably to the national economy by generating the employment, supporting the sugar industry and also serving as a source of raw material for associated industry (Zafar et al., 2025; Qureshi et al., 2019). Sugarcane makes up a sizable portion of Punjab's total cropped area, and its productivity is crucial to supplying the country's sugar needs (GOP, 2022). The sugar recovery percentage is a crucial factor in determining profitability for growers and the sugar industry because it directly affects the amount of recoverable sucrose extracted from the cane (Majeed et al., 2022; Kumar et al., 2021). Maturity stage of variety, climate, nutrients availability, pest and disease pressure, and harvest timing are some of the genetic, environmental and agronomic factors that affect sugar recovery and crop yield (Majeed et al., 2024; Hussain et al., 2018). Therefore, one of the foremost objectives of sugarcane breeding programs in Pakistan is to choose high yielding sugarcane genotypes/clones with stable and high

sugar recovery under local agro-climatic conditions (Awan et al., 2017). Recently cane quality and recovery rates have faced new difficulties due to climate change, unpredictable rainfall patterns, and temperature extremes (Raza et al., 2020). Additionally, biotic stressors like lodging, red rot, and cane brittleness can negatively influence yield and juice quality, resulting in significant financial losses (Shah et al., 2019). To find sugarcane clones that having higher cane yield, best juice quality and resistance to environmental stresses, multi-location and multi-trait evaluations are crucial (Rashid et al., 2021; Majeed et al., 2025). Therefore, the present study was undertaken to evaluate the agronomic performance and trends of sugar recovery of sugarcane genotypes/clones under Punjab's agro-climatic conditions. The objective was to identify promising sugarcane lines for commercial varietal approval, while eliminating those with poorer performance or susceptibility to key constraints.

MATERIALS AND METHODS

Ten sugarcane genotypes/clones, namely S2013-US-917, S2014-SL-1359, S2014-SL-2200, PSR-07-145, S2015-SL-89, S2015-SL-289, S2015-SL-404, S2015-SL-444, CPF-253 (Check), and HSF-240 (Check), were evaluated in a randomized complete block design (RCBD) with three replications. Healthy, disease-free, three-budded setts were planted in the spring season following recommended agronomic practices. Fertilizers were applied at the rate of 168 kg N, 112 kg P₂O₅, and 112 kg K₂O ha⁻¹, with nitrogen split into three equal doses at planting, tillering, and grand growth stages. Weeds were controlled by manual hoeing and herbicide application, and irrigation was provided according to crop needs, while plant protection measures were adopted against pests and diseases. Data recorded included germination percentage after 45 days of planting, tillers per plant at peak tillering, millable cane (000 ha⁻¹) and cane yield (t ha⁻¹) at harvest. Sugar recovery (%) was determined by collecting juice from 10 randomly selected canes per plot at different interval following the procedures of Meade and Chen (1977). Data were subjected to analysis of variance (ANOVA) using Statistix 8.1, and means were compared by the Least Significant Difference (LSD) test at a 5% probability level as described by Steel et al. (1997).

RESULTS AND DISCUSSION

The evaluated sugarcane genotypes/clones exhibited significant differences ($p \leq 0.05$) for germination percentage, tillers per plant, millable cane population, cane yield, and sugar recovery percentage (Table 1). Germination percentage

Table 1. Sugar recovery (%) of different sugarcane genotypes at different harvesting time.

Sugarcane genotypes/varieties	Sugar Recovery (%) at different harvesting time								Average (%)
	7-11-2020	1-12-2020	18-12-2020	7-1-2021	19-1-2021	3-02-2021	18-2-2021	1-3-2021	
S2013-US-917	11.96	12.29	12.88	12.9	13.05	13.1	12.7	12.53	12.68
S2014-SL-1359	10.74	11.74	12.14	12.6	12.85	12.9	12.85	12.32	12.27
S2014-SL-2200	10.93	11.83	12.07	12.4	12.55	12.6	12.87	13.15	12.30
PSR-07-145	10.3	11.1	12.7	12.9	12.95	13	13.33	13.5	12.47
S2015-SL-89	11.01	11.03	11.85	12.3	12.5	13.2	13.25	12.85	12.25
S2015-SL-289	11.58	11.68	12.22	12.29	12.95	13.3	13.41	13.12	12.57
S2015-SL-404	10.49	11.35	12.49	12.6	12.8	13	13.15	13.45	12.42
S2015-SL-444	10.07	10.98	11.5	12.12	12.7	12.8	12.9	13.33	12.05
CPF253 (Check)	11.22	12.1	12.32	12.37	12.87	13.12	13.17	12.9	12.51
HSF240 (Check)	10.13	11.8	11.86	12.3	12.44	12.75	13.11	13.23	12.20

ranged from 20.9% in S2014-SL-1359 to 55.5% in S2015-SL-404. Lower germination in S2014-SL-1359 and HSF-240 may be attributed to poor bud viability and environmental stress during the early growth stage (Majeed et al., 2022; Nazir et al., 2020). Tillers per plant varied from 0.62 in S2015-SL-404 to 1.87 in HSF-240, indicating the latter's strong tillering ability, which is in line with findings by Awan et al. (2017) that higher tillering potential contributes to improved millable cane population if tiller mortality remains low. Millable cane population ranged between 55.0 (S2014-SL-1359) and 126 (S2015-SL-289) thousand canes per hectare, while cane yield varied from 62.3 t ha⁻¹ in S2015-SL-404 to 108.7 t ha⁻¹ in CPF-253 (check). The superior cane yield of CPF-253, PSR-07-145, and S2015-SL-289 was associated with a higher millable cane population and better stalk morphology. Conversely, lower yields in S2014-SL-1359 and S2015-SL-404 were linked to thin stalks, poor stand establishment, and severe lodging, which validates the observations of Hussain et al. (2018), who reported that lodging and stalk brittleness can significantly reduce final cane

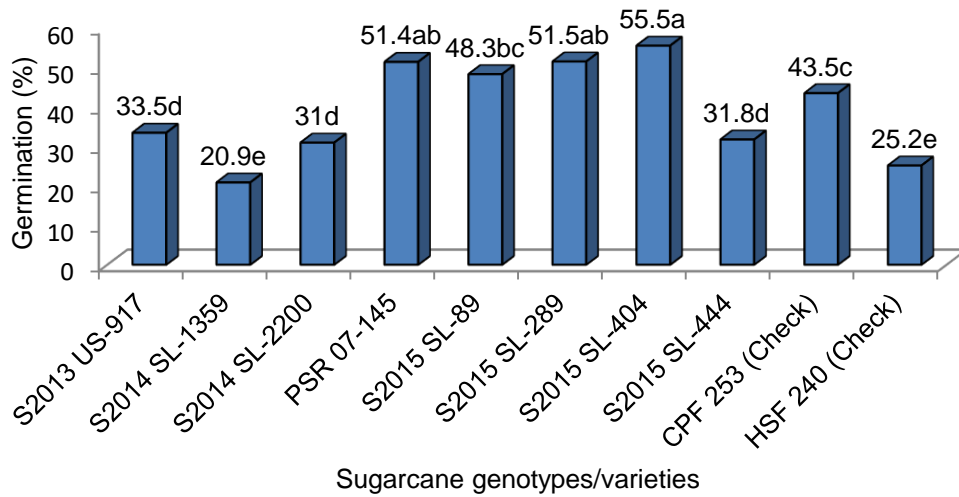


Figure 1. Germination (%) of different sugarcane genotypes.

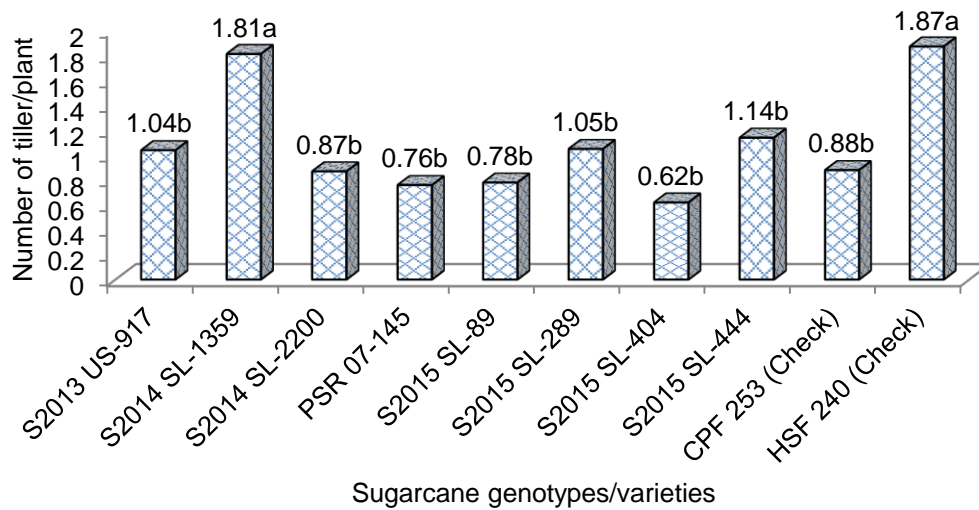


Figure 2. Number of tillers per plant of different sugarcane genotypes.

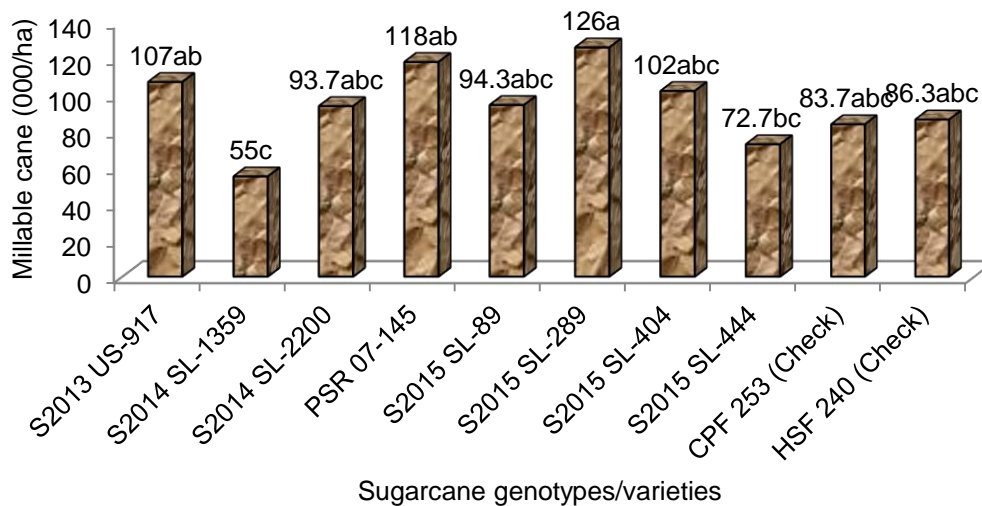


Figure 3. Number of mill able cane of different sugarcane genotypes.

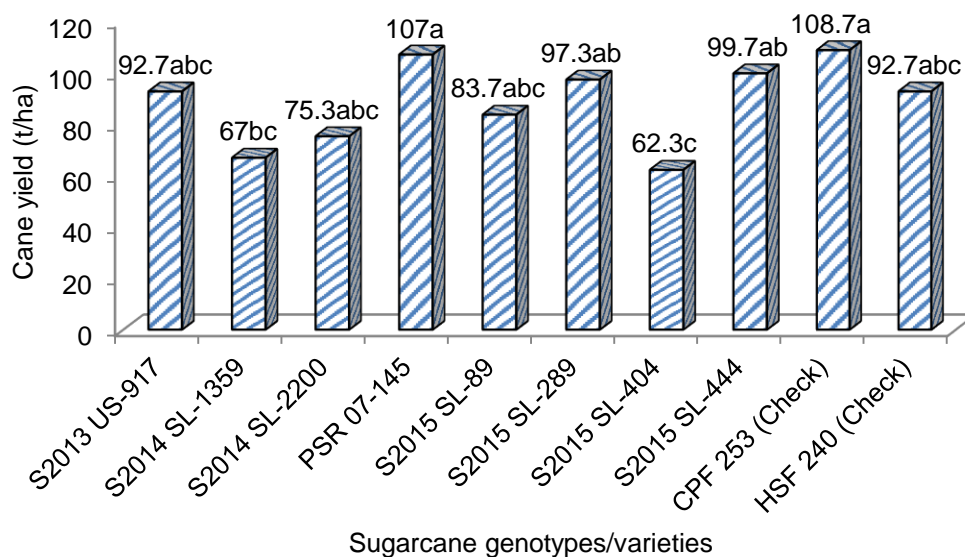


Figure 4. Sugarcane yield (t/ha) of different sugarcane genotypes.

yield. Sugar recovery percentage (SR %) recorded over eight sampling dates revealed that varietal differences were consistent across maturity stages. The highest average SR% was observed in S2013-US-917 (12.68%), followed by S2015-SL-289 (12.57%) and CPF-253 (12.51%). Lower SR% values were recorded in S2015-SL-444 (12.05%) and S2015-SL-89 (12.25%). The differences in SR% among genotypes are likely due to inherent genetic variation in juice quality parameters (Majeed et al., 2023). Moreover, clones with relatively stable SR% across all sampling dates, such as S2013-US-917 and CPF-253 demonstrate their potential for wider adaptability and suitability for delayed harvesting, a desirable trait under fluctuating harvesting schedules in Punjab (Majeed et al., 2024; Raza et al., 2020). Based on combined yield and quality performance, S2015-SL-89 and S2015-SL-289 were retained for further multiplication due to their high cane yield and satisfactory sugar recovery, whereas genotypes such as S2014-SL-1359, S2014-SL-2200, S2015-SL-404, and S2015-SL-444 were rejected due to poor yield, lower sugar content, or susceptibility to red rot and lodging. These findings are consistent with the breeding objective of selecting clones that combine high yield potential with acceptable commercial cane sugar (CCS) content while eliminating inferior lines at the final selection stage (Zafar et al., 2025; Nazir et al., 2020).

CONCLUSION

The present study demonstrated considerable variability among the tested sugarcane genotypes/clones for germination, tillering capacity, millable cane population, cane yield, and sugar recovery percentage. Among the clones, S2015-SL-89 and S2015-SL-289 revealed a desirable combination of high cane yield and reasonable sugar recovery, making them suitable candidates for further multiplication and potential commercial release. In contrast, S2014-SL-1359, S2014-SL-2200, S2015-SL-404 and S2015-SL-444 were rejected due to poor crop stand, reduced sugar content, lower yield potential and susceptibility to red rot and lodging. The results highlight the importance of integrating both quantitative and qualitative traits in the final selection stage of sugarcane breeding programs to ensure the release of varieties that meet industry requirements while maintaining adaptability to local environmental and management conditions. Continuous multi-location testing is recommended to confirm the stability of performance before large-scale adoption.

AUTHOR'S CONTRIBUTION

Abdul Majeed: Conceptualization, quality data analysis and initial draft preparation. Mahmood-UL-Hassan; Conducted field experiment, data collection and experiment design. Muhammad Kamran; Assisted in data analysis. Babar Hussain Babar; Assisted in manuscript writing. Mubashra Yasin; Statistical analysis. Salma Niaz; Result interpretation. Abdul Khaliq; Helped in preparing tables, figures, and formatting. Muhammad Shafique; Proofreading. Imran Rashid; Assisted in juice quality analysis. Muhammad Shahzad Afzal; Contributed to experimental setup and field management. Naeem

Iqbal: Assisted in reviewing and editing the manuscript. Muhammad Ehsan Khan; Critical revision and final approval of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

The data collected and analyzed during the current study are available from the corresponding author on reasonable request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable. This research did not involve human participants or animals requiring ethical approval.

CONSENT FOR PUBLICATION

All authors have read and approved the final version of the manuscript and consent to its publication.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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