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Research Article

# Evaluating Production and Quality Potential of Selected Newly Developed Promising Sugarcane Genotypes of Pakistan

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**Abstract |** In Pakistan, sugarcane cultivation is a highly significant economic and social activity that primarily produces cane sugar and generates energy. Varieties of sugarcane are crucial for increasing cane and sugar yields. To ensure the sustainability of cane and sugar production in the country, new sugarcane varieties must be developed and added to the pool of commercially cultivated varieties. To evaluate and select sugarcane varieties with better agro-morphological and biochemical characteristics under Thatta agro-ecological conditions the trial was conducted at experimental field of PARC-National Sugar and Tropical Horticulture Research Institute, at Makli, Thatta during the 2022-23 cropping season. Five sugarcane genotypes i.e., Thatta-2009, Thatta-2026, Thatta-2041, Thatta-2042, and Thatta-2043 developed from local sugarcane fuzz along with standard variety YT-55-Thatta as check were planted in three replications under RCBD experimental layout. All sugarcane genotypes exhibited different behaviors about cane yield and quality components. The sugarcane genotypes Thatta-2041, Thatta-2009, and Thatta-2043 exhibited statistically on par results with significant maximum cane yield of 147.70 131.48 and 127.52 t $ha^{-1}$, respectively, against the check variety YT-55-Thatta which recorded lower cane yield (113.24 t $ha^{-1}$). In terms of Commercial Cane Sugar Percentage (CCS%) the sugarcane genotypes Thatta-2026, Thatta-2041, and check variety YT-55-Thatta with statistically equal values displayed significantly greater mean CCS of 13.50, 13.45, and 13.43%, respectively. The lowest mean CCS of 11.61% was statistically equal to Thatta-2043. On account of improved cane yield and sugar content potential. The genotype Thatta-2041 is recommended for further testing concerning yield and quality as well as its stability in different agro-climatic zones of Sindh.

**Keywords:** Sugarcane, Fuzz, Genotypes, Yield, CCS%, Thatta

## Introduction

Sugarcane (*Saccharum officinarum* L.) is the world's most important crop for sugar production (Xu et al., 2023). It meets global energy demand and provides food and biofuels (Noman et al., 2022). Globally, the current sugarcane harvest makes up 40% of fuel production and 80% of sugarcane production with an estimated commercial value of US$90 billion (Zhang et al., 2022).

Pakistan is ranked fifth in the world and ninth overall in terms of the total area used for sugarcane farming (Sajid et al., 2023) but it lags much behind the main cane-growing nations in terms of cane yield (69.55 t $ha^{-1}$) (Muhammad et al., 2019). From 2022 to 2023, Pakistan generated 87.6 million tons of sugarcane yield in 2023-24, which is 0.4% less than the 88.0 million tons of cane produced in the previous year (GoP, 2024).

Pakistan seems to have been slower than other nations in addressing yield discrepancies. Pakistan still has a long way to go before reaching this yield level; even India has reached 70 t/ha (Afghan et al., 2023). Numerous biotic and abiotic factors, such as fluctuating night temperature, humidity, a complex genome, a lack of technology implementation, low fertility, lengthy breeding stages, inappropriate sunshine hours during the flowering phase, and a low seed setting frequency in typical conditions, all contribute to Pakistan's low sugarcane production (Sanghera et al., 2019). Apart from these facts, the cultivation of unapproved and inferior varieties of sugarcane is also a major reason for the low production of sugarcane and sugar in the country (Afzal et al., 2024). Since varieties are so important in determining yield, cultural techniques and climate variables help to capture the intrinsic yield potential that each variety possesses. The planting of improved sugarcane varieties provides a solution to the challenges of low sugarcane yield and sugar recovery (Prabha & Sharma, 2022).

It is well known that crop varieties (genotypes), growing conditions, and management techniques all have an impact on increasing sugarcane production, and sugar yield in particular (Zhao et al., 2022). To address the growing issues of yield, sugar recovery, and food insecurity, high-yielding sugarcane varieties must be developed (Saleem et al., 2023).

In Pakistan, the variety development program has been very slow and hindered because of the constrictions in fuzz production and nonexistence of systematic sugarcane cross breeding facility, for this reason, in the country many of the commercially cultivated varieties of sugarcane have been developed from exotic fuzz or direct introduction.

In the southern part of the country, especially in Thatta district of Sindh province, the flowering in many sugarcane varieties have been observed due to temperature range of 20–32 °C and humidity of 50–60% during the flowering time (Saleem et al., 2023). This natural flowering potential of the coastal region of Sindh is utilized as the cheapest source of new sugarcane variety development.

The fuzz collected from the flowering of self-crossed commercially cultivated varieties provides little genetic variation among the newly developed progenies. Despite that much progress has been achieved for variety development from local sugarcane fuzz by National Sugar and Tropical Horticulture Research Institute (NSTHRI), Thatta in Pakistan. At NSTHRI, it is a standard procedure to develop new sugarcane progenies from native sugarcane fuzz. In various pre-commercial variety evaluation studies, the cane seed of these progenies is planted and evaluated for yield and quality attributes. This method has been highly successful in developing new varieties of sugarcane at Thatta, Sindh and is not being followed anywhere else in the country.

Thus, in order to maintain greater sugarcane and sugar output, the assessment of new sugarcane strains for features related to improved economic returns is imperative. This will let the innate capability of lately evolved sugarcane material be vetted for traits associated with yield and sugar recovery prior to their release as commercial varieties (Panhwar et al., 2022).

Hence, the present field experiment was designed to explore the production and quality potential of some promising sugarcane genotypes under agro-ecological states of Thatta. It is hoped that this research will assist in the development of possible sugarcane varieties for commercial cultivation with striking features.

## Materials and Methods

**Experimental materials and site:** The field experiment was conducted during the 2022-23 planting season at the field area of National Sugar and Tropical Horticulture Research Institute (NSTHRI), Makli, Thatta ($24^{O}$ 46’34.11” N, $67^{O}$ 53’10.72” E). A total of five sugarcane genotypes, viz., Thatta-2009, Thatta-2026, Thatta-2041, Thatta-2042, and Thatta-2043, developed from local sugarcane fuzz, were evaluated for agro-morphological and biochemical parameters. The standard variety of sugarcane YT-55-Thatta was used as check.

**Physicochemical status of experimental soil:** The soil of the experimental plot was clay loam in texture, alkaline (pH 7.5) in nature, free from salinity hazards (EC: 0.96 mmhos $cm^{-1}$). Soil NPK contents were 0.08%, 3.95 ppm, and 236 ppm, respectively.

**Experimental details and crop husbandry:** The crop was planted in November 2022 and harvested in December 2023. The experiment was established according to a randomized complete block design (RCBD) with three replicates. Each genotype had a plot with five rows, each eight meters long, spaced one meter apart, and two to three budded sets with overlapping arrangements were planted. A blanket dose of 230 kg N, 115 P and 125 kg K $ha^{-1}$ was applied. Complete dose of P and K, with 1/3 of N as a Urea, Triple Supper Phosphate (TSP), and Sulphate of Potash (SOP), respectively were applied as a basal dose at the commencement of the field trial. Moreover, the leftover N was applied in two equal splits at 45 and 90 days after planting. Standard irrigation practices, plant protection measures, and other agronomic practices were properly adopted.

**Data collection of agro-morphological and biochemical traits:** The observations on yield contributing traits, *viz*. cane thickness, cane height, and number of millable canes were noted from ten randomly taken tagged middle plants from the middle row at harvest and averaged. For cane yield data, all without trash stalks of each plot were weighed and transformed to t $ha^{-1}$. The analysis of juice quality attributes, *viz*. Brix percentage, Pol percentage, Purity percentage, and Commercial Cane Sugar Percentage (CCS %) was carried out at the harvesting time from the composite juice of 10 cane stalk samples by following standard procedures (Meade & Chen, 1977).

Brix value of cane juice was recorded using digital refractometer. Pol% was estimated using Polarimeter. Purity% = Pol%/Brix%X100, CCS % = {Pol % – (Brix % – Pol %) X 0.4} X 0.74.

**Statistical analysis:** The data of all studied parameters were analyzed statistically using Statistix 8.1 software. Analysis of variance (ANOVA) and LSD test at a confidence level of $p \leq 0.05$ was applied to discriminate the superiority of the means of different varieties.

## Results

**Analysis of variance:** According to the analysis of variance results, there were highly significant differences among the genotypes for cane height, millable canes, and cane yield, whereas, non-significant for cane thickness at probability level ($p \leq 0.05$). Regarding qualitative parameters, the differences in the mean values of genotypes for brix, pol, and CCS were highly significant ($p \leq 0.05$), while, non-significant for purity (Table 1 & 2).

Thatta which showed lowermost cane height (255.33 cm).

Regarding the millable canes, it was noticed that all the genotypes in the trial demonstrated variable behavior in relation to this crucial genetic characteristic. The millable canes ha$^{-1}$ (85666.66) were significantly higher in Thatta-2009 followed by Thatta-2041, and Thatta-2043 with statistically differing mean values of 83000.0, and 76666.66 millable canes ha$^{-1}$, respectively. Compared to the check variety, the genotypes Thatta-2009, Thatta-2041, and Thatta-2043 showed 20.23, 17.67, and 10.86% greater number of millable canes ha$^{-1}$, respectively. In contrast, the genotype Thatta-2042, check variety YT-55-Thatta, and Thatta-2026 recorded statistically equivalent lowest mean values of 66666.6, 68333.33, and 70000.0 millable canes ha$^{-1}$, respectively. According to the data in Table 3, the genotype Thatta-2041 was the best by exhibiting significantly highest mean cane yield of 147.70 t ha$^{-1}$, followed by Thatta-2009, and Thatta-2043 with statistically similar mean cane yield of 131.48 and 127.52 t ha$^{-1}$, respectively. As such, the sugarcane genotypes Thatta-2041, Thatta-2009, and Thatta-2043 displayed 23.33,12.34, and 11.19% higher values of cane yield, respectively, over check variety. The lowest mean cane yield of 113.24 t ha$^{-1}$ was recorded from check variety YT-55-Thatta. Moreover, the genotypes Thatta-2042, and Thatta-2026 exhibited intermediate performance mean cane yield of 118.22, and 120.16 t ha$^{-1}$, respectively, but remained statistically on par with check variety YT-55-Thatta.

**Table 1.** Mean squares for quantitative parameters of sugarcane genotypes evaluated at NSTHRI, Thatta during 2022-23

| Source | df | Cane thickness | Cane height | Millable canes | Yield |
|---|---|---|---|---|---|
| Replications | 2 | 3.28395 | 103.41 | 15.389 | 61.556 |
| Genotypes | 5 | 1.02840 NS | 1957.67 ** | 191.656 ** | 465.838 ** |
| Error | 10 | 2.86914 | 129.20 | 12.189 | 14.756 |

**Table 2.** Mean squares for qualitative parameters of sugarcane genotypes evaluated at NSTHRI, Thatta during 2022-23

| Source | df | Brix | Pol | Purity | CCS |
|---|---|---|---|---|---|
| Replications | 2 | 0.82099 | 42.6667 | 63.5000 | 20.1667 |
| Genotypes | 5 | 2.25802 ** | 2.6469 ** | 4.3943 NS | 1.6459 ** |
| Error | 10 | 0.22099 | 0.2667 | 4.5000 | 0.1667 |

**Morphological parameters:** The data regarding morphological parameters in Table 3 show that the genotypes Thatta-2026, Thatta-2009, check variety YT-55-Thatta, and Thatta-2041 produced maximum mean cane thickness of 27.88, 27.77, 27.55, and 27.00 mm, respectively. Moreover, the genotypes Thatta-2042 and Thatta-2043 had cane stalks that were relatively thinner, with mean values of 26.77 and 26.44 mm, respectively. It was noticed that the variation among the genotypes for this trait was not pronounced. In the case of height, all the genotypes showed a tremendous genetic variation concerning this trait (Table 3). The genotype Thatta-2042 had significantly longer canes with a length of 329.44 cm followed by Thatta-2041, and Thatta-2043, which displayed statistically identical findings with cane height of 314.33 and 312.66 cm, respectively.

Moreover, the Thatta-2026, and Thatta-2009 were found to be the next better performing sugarcane genotypes with cane height of 300.22, and 293.66 cm, respectively, in comparison to the check variety YT-55-

**Table 3.** Mean data of quantitative traits of different sugarcane genotypes evaluated at NSTHRI, Thatta during 2022-23

| Genotypes | Cane thickness (mm) | Cane height (cm) | Millable canes (ha$^{-1}$) | Cane yield (t ha$^{-1}$) |
|---|---|---|---|---|
| Thatta-2009 | 27.77 | 293.66b | 85666.66a | 131.48b |
| Thatta-2026 | 27.88 | 300.22b | 70000.00c | 120.16c |
| Thatta-2041 | 27.00 | 314.33ab | 83000.00ab | 147.70a |
| Thatta-2042 | 26.77 | 329.44a | 66666.66c | 118.22c |
| Thatta-2043 | 26.44 | 312.66ab | 76666.66b | 127.52b |
| YT-55-Thatta | 27.55 | 255.33c | 68333.33c | 113.24c |
| CV% | 6.22 | 3.78 | 4.65 | 3.03 |
| LSD 0.05% | NS | 20.67 | 6.35 | 6.98 |

**Bio-chemical attributes:** The results regarding bio-chemical attributes in Table 4 shows that the genotype Thatta-2041 exhibited the highest mean value for brix (21.72%). Moreover, Thatta-2026 and check variety YT-55-Thatta displayed next better results for brix with statistically identical mean values (21.22%).

**Table 4.** Mean data of qualitative traits of different sugarcane genotypes evaluated at NSTHRI, Thatta during 2022-23

| Genotypes | Brix% | Pol% | Purity% | CCS% |
|---|---|---|---|---|
| Thatta-2009 | 20.16 cd | 17.61 c | 87.35 | 12.60 b |
| Thatta-2026 | 21.22ab | 18.76 a | 88.40 | 13.50 a |
| Thatta-2041 | 21.72 a | 18.85 a | 86.78 | 13.45 a |
| Thatta-2042 | 20.55 bc | 17.80 bc | 86.61 | 12.68 b |
| Thatta-2043 | 19.33 d | 16.44 d | 85.05 | 11.61 c |
| YT-55-Thatta | 21.22 ab | 18.70 ab | 88.12 | 13.43 a |
| CV% | 2.27 | 2.86 | 2.44 | 3.17 |
| LSD 0.05% | 0.85 | 0.93 | NS | 0.74 |

The remaining genotypes were incapable of competing with check variety with regard to mean brix readings. In terms of pol%, the genotypes Thatta-2041, and Thatta-2026 were found to be superior to the check variety and other genotypes by producing significantly maximum mean pol values of 18.85, and 18.76%, respectively.

Check variety YT-55-Thatta displayed the next better mean pol value (18.70%) followed by Thatta-2042, and Thatta-2009 with statistically different mean pol values of 17.80, and 17.61%, respectively.

The genotype Thatta-2043 had the statistically lowest mean pol reading (16.44%). In the case of CCS% (Commercial Cane Sugar) the sugarcane genotypes Thatta-2026, Thatta-2041, and check variety YT-55-Thatta demonstrated significantly higher mean CCS of 13.50, 13.45, and 13.43%, respectively, and remained statistically equal.

Moreover, the genotypes Thatta-2042, and Thatta-2009 showed the next encouraging results with statistically similar CCS values of 12.68 and 12.60%, respectively, but could not outperform the check variety. The lowest mean CCS of 11.61% was recorded from Thatta-2043 (Table 4).

## Discussion

Yield ability is a convoluted course that is influenced by its attributes and their mutual interlinkage (Uzair et al., 2022). The increased and decreased cane harvests in this experiment might have resulted from the genotypes of sugarcane having different underlying genetic potential.

In a recent study, Panhwar et al. (2022) described that sugarcane genotypes with distinct internal genetic makeup are capable of generating satisfactory results for yield per hectare under specific and multiple set of environmental situations.

Similarly, Desalegn et al. (2023) reported that the differences in the performances of the varieties concerning yield and yield components could be attributed to differences in their ability to respond to the applied inputs, which affects their ability to grow under given conditions.

In this experiment, the synergistic relationship of heavy and tall cane stools combined with an acceptable quantity of millable canes might have contributed to the increase in yield in Thatta-2041. The genotype Thatta-2009 despite having comparatively reduced cane length exhibited the next good performance for cane yield as a result of hefty millable stools which might have made up for the little stalk height.

Additionally, the genotype Thatta-2043 showed subsequent promising results in terms of cane yield, perhaps as a result of the collective stimulus of moderately thick, long, and heavy cane stalks.

Furthermore, the sugarcane genotype Thatta-2041 despite bearing fairly heavier cane stalks had a lesser yield, most likely as a result of having fewer millable canes. The low tonnage in standard variety YT-55-Thatta could be attributed to relatively shorter cane stalks and a fairly lower stalk population.

These findings are consistent with those of Birhanie et al. (2020), who found that about 70 percent of millable canes, 27% of cane length, and 3% of cane girth contribute to cane yield. In a similar vein, Ganapathy and Purushothaman (2022) showed that factors influencing cane yield include plant height, and the quantity of millable stalks.

Riajaya et al., (2022) noted that in sugarcane two highly important yield components that determine yield improvement were plant height and plant population (number of canes) before harvest.

Belay et al. (2023) reported that by selecting the specific genotypes from the examined materials that produced the greatest number of tillers and stalks, it is possible to develop sugarcane genotypes with improved yield.

Better-quality sugar production requires a well-matured, high-sugar content sugarcane variety with acceptable juice extraction and purity. In this experiment, the behavior of all sugarcane genotypes under study varied when it came to quality measures, most likely due to their varying genetic makeup.

The combined association of brix, pol, and purity values established the maximum CCS% in genotypes

Thatta-2026, Thatta-2041, and the check variety YT-55-Thatta. However, Thatta-2026 was found to have a little lower pool percentage than Thatta-2041 and YT-55-Thatta, but because of its higher purity, it yielded comparatively higher CCS values.

Moreover, genotypes Thatta-2042 and Thatta-2009 despite having better purity% demonstrated slightly lesser performance concerning this bio-chemical trait as they had moderate values of brix and pol% which contributed to their CCS%. The genotype Thatta-2043 showed comparatively lowest result because of producing the lowest brix, pol, and purity values which could not contribute to increasing its CCS%.

The results conform with Panhwar et al. (2022) who reported that the genotype's lower pol content and greater brix value may cause the purity value to fall, which could ultimately lead to a lower CCS. The inherent genetic development and structural variances of sugarcane varieties, as well as variations in gene networks for sugar signaling, may be responsible for the varietal differences in these biochemical properties (Chen et al., 2019).

The differences in the capacities of different varieties to produce and store soluble solid compounds and accumulate sucrose may be the cause of the variation in brix and pol values. (Urgesa & Keyata 2021). The effective role of sugarcane varieties on purity percent has been reported by (Yousif et al., 2023; Riajaya et al., 2022) who identified substantial differences among examined varieties for purity percent.

## Conclusion

It is concluded that sugarcane genotype Thatta-2041 because of its superior cane yield and sugar content capacity can deliver greater economic returns to both sugar mills and the farming community. As a result, it is suggested to conduct additional research on the same variety's cane output, quality, and stability across Sindh's various agro-climatic zones.

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## Author Contribution

RNP: Conceptualization, investigation, data visualization, original draft preparation; MC: Investigation, data visualization and processing; GMK: Supervision and technical guidance; AFS: Supervision and critical revision; SA: Tabular information and editing; AHM: Investigation and final draft editing; AAK: Review and editing. All authors approved and assumed the responsibility of the content of MS.

## Conflict of Interest

No competing interests are disclosed by the authors.

## References


Afghan S, Khan ME, Arshad WR, Malik KB, Nikpay A. 2023. Economic importance and yield potential of sugarcane in Pakistan. *IntechOpen*. doi: 10.5772/intechopen.105517.

Afzal MS, Zafar M, Ahmad HB, Hassan MU, Yasin M, Babar BH, Naheed R. 2024. Performance evaluation of sugarcane clones at preliminary yield trial. *Pakistan Journal of Biotechnology 21*(2): 457–462.

Belay T, Gedebo A, Tena E. 2023. Variability, heritability and genetic advance in sugarcane (*Saccharum* spp. hybrid) genotypes. *Cogent Food & Agriculture 9*(1): 1–16.

Birhanie N, Legesse H, Jalata Z. 2020. Effect of blended fertilizer and levels of phosphorus on yield and juice quality of sugarcane at Fincha Sugar Estate, Ethiopia. *International Journal of Plant Production 4*(2): 21.

Chen Z, Qin C, Wang M, Liao F, Liao Q, Liu X, Yangrui L, Lakshmanan P, Long M, Huang D. 2019. Ethylene-mediated improvement in sucrose accumulation in ripening sugarcane involves increased sink strength. *BMC Plant Biology 19*: 285.

Desalegn B, Kebede E, Legesse H, Fite T. 2023. Sugarcane productivity and sugar yield improvement: selecting variety, nitrogen fertilizer rate, and bioregulator as a first-line treatment. *Heliyon 9*(4): e15520.

Ganapathy S, Purushothaman RS. 2022. Evaluation of early maturing sugarcane clones for yield, quality and its contributing traits in East Coast Zone of Tamil Nadu. *International Journal of Plant & Soil Science 34*(20): 575-581.

Meade GP, Chen JCP. 1977. *Cane Sugar Handbook* (10th ed.). Wiley Inter Science, John Wiley and Sons, New York, p. 947.

Muhammad IT, Mohammad IJ, Iftekhar N, Naeem A, Abid MA. 2019. Face for enhancing cane & sugar yield in Pakistan. *Global Scientific Journals 7*(3): 670-686.

Noman M, Siddique I, Saleem B, Ilyas S, Ali S, Khan MR. 2022. In silico dissection and expression analysis of sucrose synthase gene family in sugarcane. *Sugar Technology 24*(6): 1766–1777.

GOP. 2024. *Pakistan Economic Survey 2023-24*. Finance and Economic Affairs Division, Ministry of Finance, Government of Pakistan: Islamabad, Pakistan.

Prabha N, Sharma RK. 2022. Performances evaluation of sugarcane genotypes for yield and yield attributing characters. *The Pharma Innovation Journal 11*(10): 1020-1024.

Riajaya PD, Hariyono B, Cholid M, Kadarwati FT, Santoso B, Djumali, Subiyakto. 2022. Growth and yield potential of new sugarcane varieties during plant and first ratoon crops. *Sustainability 14*: 14396.

Sajid M, Amjid M, Munir H, Valipour M, Rasul F, Khil A, Alqahtani MD, Ahmad M, Zulfiqar U, Iqbal R, Ali MF, Ibtahaj I. 2023. Enhancing sugarcane yield and sugar quality through optimal application of polymer-coated single super phosphate and irrigation management. *Plants 12*: 3432.

Saleem B, Uzair M, Noman M, Attia KA, Zhang M, Alwahaibi MS, Zahra N, Naeem MK, Mohammed AA, Fiaz S, Kimiko I, Khan MR. 2023. Evaluation of sugarcane promising clones based on the morphophysiological traits developed from fuzz. *PeerJ 11*: e15646.

Sanghera GS, Malhotra PK, Singh H, Bhatt R. 2019. Climate change impact in sugarcane agriculture and mitigation strategies. *Harnessing Plant Biotechnology and Physiology to Stimulate Agricultural Growth 1*(1): 99–115.

Panhwar RN, Soomro AF, Chohan M, Bhatti IB, Mari AH, Arain S, Ahmad S. 2022. Assessment of variation in newly developed sugarcane genotypes for morphological and quality-associated parameters. *Pakistan Journal of Agricultural Research 35*(3).

Urgesa GD, Keyata EO. 2021. Effect of harvesting ages on yield and yield components of sugarcane varieties cultivated at Finchaa Sugar Factory, Oromia, Ethiopia. *International Journal of Food Science 2021*(1): 2702095.

Uzair M, Patil SB, Zhang H, Kumar A, Mkumbwa H, Zafar SA, Chun Y, Fang J, Zhao J, Khan MR, Yuan S. 2022. Screening direct seeding-related traits by using an improved mesocotyl elongation assay and association between seedling and maturity traits in rice. *Agronomy 12*(4): 97

Xu Z, Kong R, An D, Zhang X, Li Q, Nie H, Liu Y, Su J. 2023. Evaluation of a sugarcane (*Saccharum* spp.) hybrid F1 population phenotypic diversity and construction of a rapid sucrose yield estimation model for breeding. *Plants 12*: 647.

Yousif EMM, Mohammad AEE, Galal MOA. 2023. Impact of the age at harvest on yield and quality of some promising sugarcane varieties. *Egyptian Journal of Agriculture Research 101*(2): 382-392.

Zhang Q, Qi Y, Pan H, Tang H, Wang G, Hua X, Wang Y, Lin L, Li Z, Li Y, Yu F. 2022. Genomic insights into the recent chromosome reduction of autopolyploid sugarcane *Saccharum spontaneum*. *Nature Genetics 54*(6): 885–896.

Zhao Y, Liu J, Huang H, Zan F, Zhao P, Zhao J, Deng J, Wu C. 2022. Genetic improvement of sugarcane (*Saccharum* spp.) contributed to high sucrose content in China based on an analysis of newly developed varieties. *Agriculture 12*: 1789.