

INFLUENCE OF WEATHER PARAMETERS ON SUCROSE ACCUMULATION IN SUGARCANE (*SACCHARUM OFFICINARUM* L.)

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ABSTRACT

The ripening of sugarcane is largely influenced by weather factors such as sunlight, temperature, and rainfall. This study evaluated ten sugarcane clones over two crop years (2023–24 and 2024–25) under the agro-climatic conditions of Andhra Pradesh, India, to assess the effect of weather parameters on sucrose accumulation. The clones were observed from October to February and data on sucrose percentage and weather elements (maximum and minimum temperature, rainfall, and bright sunshine hours (BSSH)) were collected. Correlation analysis revealed that BSSH had a strong positive correlation ($r = 0.75$) with mean sucrose, followed by minimum temperature ($r = 0.54$), while rainfall showed a negative correlation ($r = -0.68$). These results affirm the critical role of incident sunlight and cold weather in enhancing ripening. Clones 2022A 93, 2022A 203, and 2022A 88 demonstrated superior performance across seasons and can be considered for further line development or trait introgression breeding.

Keywords: Sugarcane ripening, Sucrose, Weather impact, Bright sunshine hours, Clone selection

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is a commercially important and climate-sensitive crop, extensively cultivated for its high sucrose content, which serves as a primary source of sugar production in tropical and subtropical regions. Among the numerous factors influencing sugarcane productivity and sugar recovery, weather parameters play a pivotal role in modulating sucrose accumulation in the stalks. The process of ripening, which involves the accumulation of sucrose in internodes, is closely associated with environmental factors. In subtropical and

tropical regions, ripening typically begins in the post-monsoon period when vegetative growth slows due to declining temperatures and light intensity (Legendre, 1975; Samui et al., 2003; Shanthi et al., 2023).

Optimal sucrose accumulation generally requires a well-balanced combination of warm temperatures during the growth phase and cool, dry conditions during the ripening phase. According to Legendre (1975), sunlight particularly bright sunshine hours (BSSH) plays a pivotal role in ripening, whereas rainfall during the ripening period may hinder sucrose accumulation by promoting continued

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vegetative growth. Excessive rainfall and elevated temperatures during maturation can reduce sucrose content due to enhanced respiration and dilution effects (Verma *et al.*, 2019). Similarly, fluctuations in relative humidity, solar radiation, and wind speed influence stomatal activity, photosynthesis, and enzymatic processes involved in sucrose metabolism (Scarpari and Beauclair, 2004).

The interaction between weather factors such as sunlight, temperature, and rainfall varies significantly across genotypes and environments, necessitating location-specific studies to optimize harvest timing and clone selection. Understanding these interactions is critical for maximizing sugar recovery and ensuring sustainable sugarcane production under increasing climate variability (Mehdi *et al.*, 2024).

The present investigation aimed to evaluate the performance of sugarcane clones under the agro-climatic conditions of Andhra Pradesh over two seasons, focusing on the effect of monthly weather variables on sucrose accumulation. Such studies provide valuable insights for refining varietal adaptation strategies and improving crop management practices to enhance productivity and sugar yield in the region.

MATERIAL AND METHODS

Ten sugarcane clones (2022A 88, 2022A 203, 2022A 241, 2022A 108, 2022A 224, 2022A 29, 2022A 143, 2022A 165, 2022A 93, and 2022A 220) were evaluated during the crop years 2023–24 and 2024–25 at the Regional Agricultural Research Station, Anakapalle, using a Randomized Block Design (RBD) with three replications. These clones were planted under uniform field conditions following standard agronomic practices. Sucrose percentage in cane juice was

measured at maturity (February) for two consecutive years (2023–24 and 2024–25). Simultaneously, monthly weather data from October to February, including rainfall (mm), maximum and minimum temperatures (°C), and bright sunshine hours (BSSH), were obtained from the agrometeorological station (RARS, Anakapalle). The average mean sucrose percentage across both years was computed for each clone, and mean monthly weather parameters were calculated for the ripening period. To assess the relationship between environmental variables and ripening, Pearson's correlation coefficients (r) were determined between the mean sucrose values and each climatic parameter.

RESULTS AND DISCUSSION

Sucrose Accumulation in Clones

This variation in climatic conditions corresponded with changes in sucrose accumulation among the ten sugarcane clones. Most clones showed higher sucrose percentage in 2024–25, coinciding with drier and sunnier weather, suggesting favorable conditions for ripening. Clone 2022A 93 recorded a mean sucrose of 22.57%, followed by 2022A 203 (21.62%) and 2022A 88 (21.14%), which consistently outperformed other clones in both years (Table 1 and Fig 1).

Correlation between weather parameters and sucrose

To assess the influence of weather factors on ripening, correlation analysis was conducted between the mean sucrose percentage (across two years) and the seasonal averages of rainfall, maximum and minimum temperature, and BSSH (Table 2 and Fig 2).

Bright Sunshine Hours (BSSH) showed the strongest positive correlation ($r = 0.75$) with sucrose content. This finding aligns closely

Table 1. Mean Sucrose Percentage of Ten Sugarcane Clones across Two Crop Years (2023–24 and 2024–25)

Clone	Mean Sucrose (%)	Clone	Mean Sucrose (%)
2022A 93	22.57	2022A 143	18.62
2022A 203	21.62	2022A 108	18.58
2022A 88	21.14	2022A 220	18.89
2022A 224	19.6	2022A 29	18.4
2022A 165	18.63	2022A 241	17.83

Table 2. Pearson’s correlation coefficients between mean sucrose percentage and climatic parameters

Weather Parameter	r (Correlation with Mean Sucrose)
Rainfall	“0.68
Max Temperature	0.41
Min Temperature	0.54
BSSH	0.75

with Legendre (1975), who identified incident sunlight as a major factor driving ripening by enhancing photosynthetic efficiency. Increased sunlight leads to better dry matter partitioning and higher sugar storage in the cane stalks (Legendre, 1975).

Minimum temperature also exhibited a moderate positive correlation ($r = 0.54$). Warmer nights during the ripening phase may facilitate enzymatic activity involved in sucrose synthesis and translocation. This supports previous findings that, although cooler temperatures can reduce vegetative growth and favor ripening, excessively low temperatures may hinder sugar accumulation. Maximum temperature had a weaker positive correlation ($r = 0.41$), indicating that day temperatures were not as critical as night temperatures or sunlight in this subtropical environment (Legendre, 1975).

Rainfall was negatively correlated with sucrose content ($r = “0.68$), suggesting that

excess rainfall during ripening is detrimental to sucrose accumulation. This is likely due to reactivation of vegetative growth and dilution of sugars in the cane juice under wet soil conditions. Notably, during December 2023–24, rainfall peaked at 179 mm, and many clones recorded lower sucrose values compared to the following year (Cardozo *et al.* 2015).

Clone Performance and Environmental Responsiveness

Among the clones evaluated, 2022A 93, 2022A 203, and 2022A 88 stood out for their consistent high sucrose content across seasons. These genotypes appear to be more responsive to increased sunlight and less sensitive to rainfall, suggesting greater physiological efficiency in partitioning assimilates to sucrose under varying environmental conditions.

Conversely, clones like 2022A 241 and 2022A 29 performed poorly, with mean sucrose

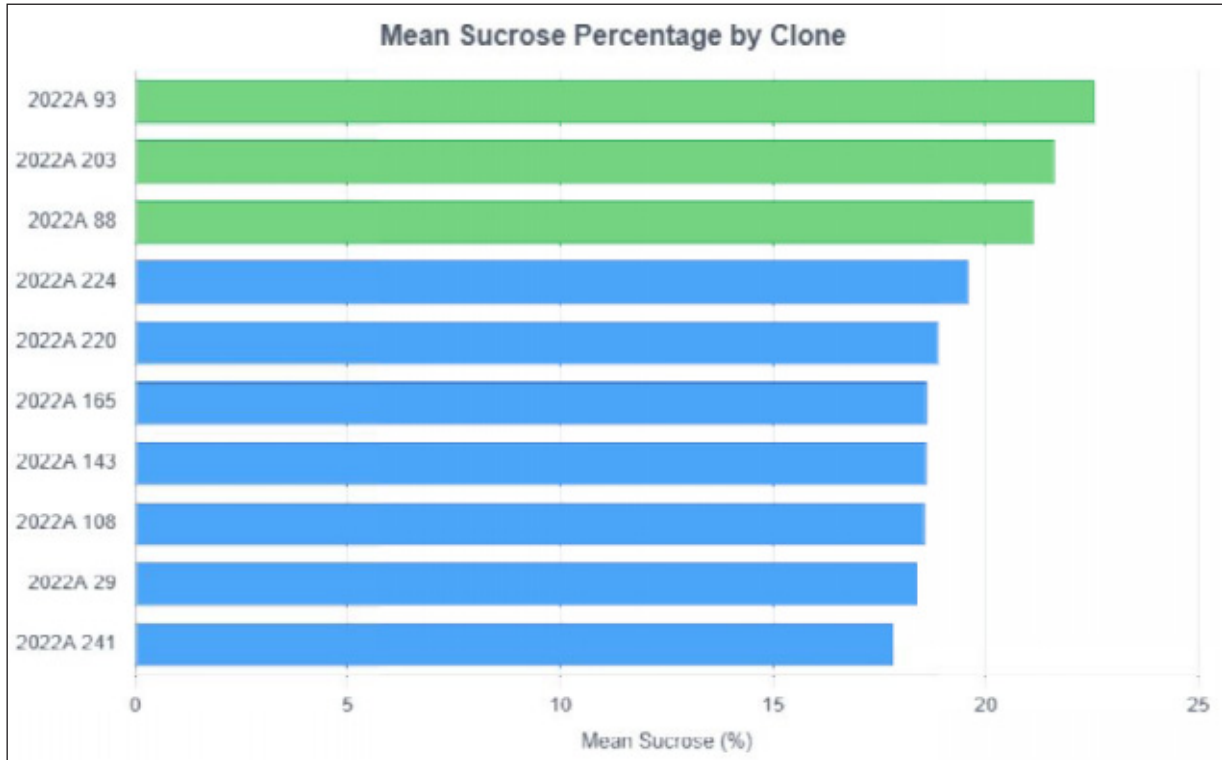


Fig 1. Mean sucrose concentration in ten sugarcane clones during 2023–24 and 2024–25

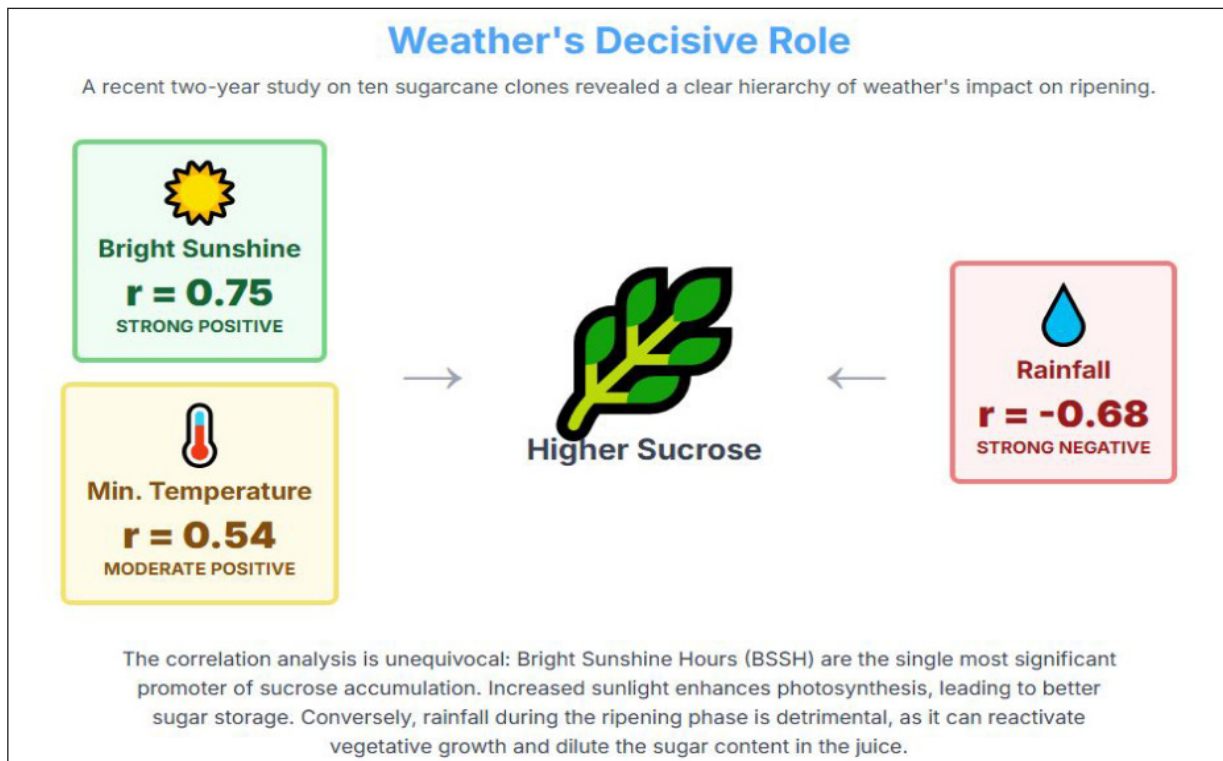


Fig. 2. Pearson's correlation of sucrose content with bright sunshine, temperature, and rainfall

levels below 18.5%, indicating either a late-ripening nature or lower adaptation to the given climatic conditions. These genotypes may require a longer maturation window or more favorable environments to express their full potential.

CONCLUSION

The results of this study indicate that sunlight is the most influential climatic factor affecting sugarcane ripening in subtropical conditions. In the present context, higher BSSH and lower rainfall created an optimal environment for sucrose accumulation. The impact of temperature, though present, was less direct, acting more through interactions with sunlight than as an independent factor. Moreover, the negative impact of rainfall during the ripening phase underscores the importance of regulated irrigation or rain sheltering practices in sugarcane farming during critical ripening stages, especially in regions experiencing untimely winter rainfall.

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