SHORT COMMUNICATION

SUGARCANE RATOON YIELD DECLINE UNDER THREE IRRIGATION SYSTEMS: A CASE OF UBOMBO SUGAR

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The phenomenon of yield decline with successive ratoons of sugarcane, known as Ratoon Yield Decline (RYD), is primarily influenced by the genotype, the growing environment and the genotype x environment interaction. Irrigation or soil moisture management is a major component influencing sugarcane growth, especially in the Eswatini Sugar Industry, where 100% of the crop is irrigated. This study aimed to determine the rate of RYD in different irrigation systems. Annualised data on the Tons of Sucrose per Hectare (TSHA), spanning from 1997 to 2022, were used on Variety N25, which was irrigated by using centre pivot (13 fields), furrow (18 fields) and sprinkler irrigation (six fields). Only fields that had up to nine ratoons from all the irrigation systems were analysed, and a linear regression model was used to discern the significant differences. The RYD rate was significant ($P<0.05$) in all the irrigation systems, and the slopes indicated that it was greater in the centre pivot system (-0.349 TSHA), followed by furrow (-0.186 TSHA) and sprinkler (-0.08 TSHA) systems. The findings of this study are crucial for cost-benefit projections, while planning for irrigation investment, as well as for forecasting sugarcane replant programmes.

Keywords: Sugarcane, ratoon yield decline, irrigation systems, sugarcane Variety N25, Ubombo Sugar, Eswatini

Introduction

Sugarcane (*Saccharum officinarum* L.) is the most important sugar crop in the world, and it accounts for more than 75% of the global sugar production (Marin *et al*., 2019). The Eswatini Sugar Industry (ESI) is the second-largest, in terms of the area under production, in the southern African region, and it is the fourth-largest on the African continent after South Africa, Egypt and Sudan (Hess *et al*., 2016). The ESI has established multiple initiatives relating to rural development and poverty alleviation, by providing social services facilities, incomes and the commercialisation of farming (Liversage and Jonckheere, 2014). The ESI accounts for 74% of the total agricultural exports, 16% of the total export earnings and about 13% of the Gross Domestic Product (GDP) (SSA, 2015); therefore, sugarcane plays a crucial role in the country's economy.

The sugarcane crop can regrow after harvesting, enabling several successive harvesting periods without going back to land preparation and planting; this phenomenon is termed ‘ratooning’. The yields of successive ratoons have the tendency to decline over the years, and this is termed Ratoon Yield Decline (RYD). A wide range of factors have been reported to affect RYD, including the genotype, the growing environment and the interaction between the genotype x environment. The rate of RYD is dependent on the soil type (e.g. fertility and soil compaction) and cutting season (Dlamini and Zhou, 2022), crop management practices (e.g. mechanical harvesting), insect pests and disease pressure, as well as weeds (Marin *et al*., 2019). Limited studies have explored the effect of the different irrigation systems on the RYD, notably in the ESI, where 100% of the sugarcane crop grown in the country is irrigated by means of various systems. The aim of this investigation was, therefore, to determine the rate of RYD in centre pivot, sprinkler and furrow irrigation systems.

Materials and Methods

Study site description

The study was conducted at the Ubombo Sugar Ltd, Eswatini, which is located at a latitude of -26.8, a longitude of 31.7 and an altitude of 106 m. The climate at Ubombo is semi-arid, with an average annual precipitation of 624.7 mm, which falls mostly between October and March. The average air temperatures are 17.1°C in the coldest month (July) and 27.0°C in the warmest month (December).

Data collection and analysis

All the data used in this study were sourced from CanePro, a business software system that is widely used in the sugar industry across the southern African region. Data were obtained for the period 1997 to 2022 from fields planted with Variety N25 and having up to nine ratoons (10 crops, including the plant crop). A total of 37 fields met this criterion, of which 13 were irrigated by centre pivots, 18 by furrows, and the remaining six were irrigated by sprinklers. The annual 10-year cycle of Tons of Sucrose per Hectare (TSHA) for all the fields, grouped into irrigation systems, were analysed by using the linear regression model. Lines were plotted in Microsoft Excel to determine the slopes of the RYD and the y-intercepts of the different RYD data. The three slopes from the three irrigation systems were subjected to the F-test at 95% ($P<0.05$), using Excel to test their significance.

Results

Figure 1 presents the results of the RYD for the different irrigation systems. It summarises the individual cycles and the average of all the cycles, as shown by the dotted trend lines. The equations with the slopes and y-intercepts represent the averages of these cycles in the different irrigation systems.

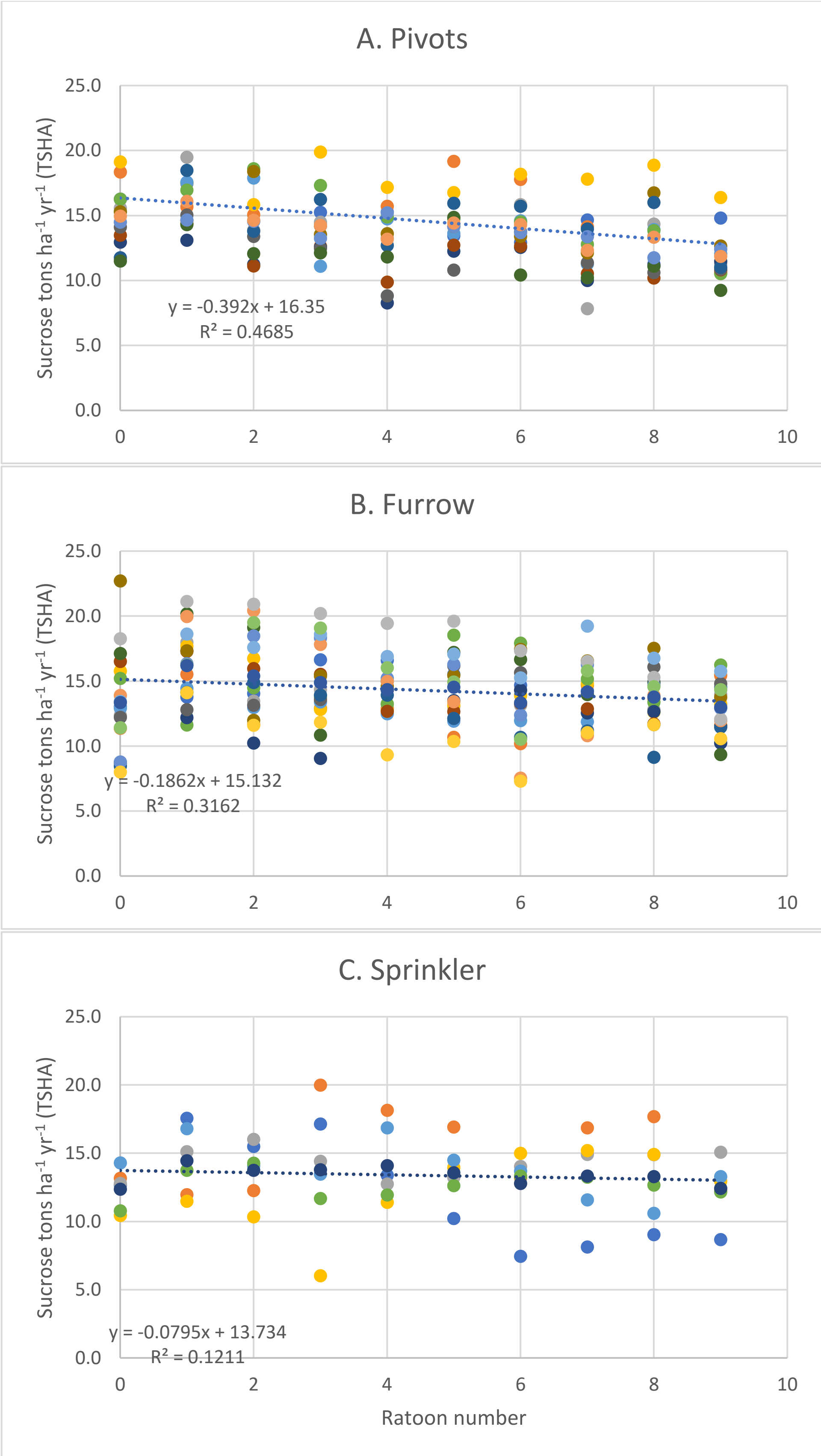

Figure 1. Ratoon yield decline of sugarcane grown under the (a) centre pivot, (b) furrow and (c) sprinkler irrigation systems for 9-year ratoon cycles between the years 1997 and 2022 at Ubombo Sugar, Eswatini

The RYD rate for all the different irrigation systems was significant ($P<0.05$) (data not presented); the slopes indicated that it was higher in the centre pivot system (-0.349 TSHA), followed by the furrow (-0.186 TSHA) and the sprinkler systems (-0.08 TSHA). The highest y-intercept was recorded for centre pivot irrigation (16.35 TSHA), followed by furrow (15.13) and sprinkler irrigation (13.73).

Discussion

The slopes computed from the three irrigation systems showed significant differences, which indicated a marked decline in sucrose production over 10 years. This decline occurred, regardless of the irrigation system that was used. The higher rate of RYD in centre pivots implies that if the yield has reached a certain threshold, it would be better to start replanting on the centre pivots if a choice had to be made between systems compared to the furrow and sprinklers. The high initial returns on the TSHA will justify the high cost of replanting. The good part is that this is where the y-intercept is the highest, which implies that the starting point at ratoon zero is higher in this system than in the others. The sprinkler irrigation system was the least in both the RYD rate and the y-intercept, while the furrow system was intermediate to the two systems in both the RYD rate and Y-intercept.

The phenomenon of RYD has been investigated and reported by other researchers. Dlamini and Zhou (2022) reported that the influence of the soil type and the different seasons were highly influential on the rate of RYD across the ESI. These authors reported a higher rate of RYD in the early (-0.33 TSHA) and late (-0.32 TSHA) cuts than in the mid-season cuts (-0.26 TSHA). Poor-draining soils were reported to have higher (-0.38 TSHA) RYD rates than well-drained soils (-0.25 TSHA).

Conclusion

The study aimed to determine the rate of RYD of sugarcane grown under three irrigation systems. Overall, the RYD rate is higher under centre pivot irrigation, followed by the furrow and sprinkler irrigation systems. The findings of this study are crucial for cost-benefit projections, while choosing an irrigation system, and for forecasting sugarcane replant programmes.

References

Dlamini NE and Zhou M (2022). Soils and seasons effect on sugarcane ratoon yield. *Field Crops Res* 284: 108588.

Hess TM, Sumberg J, Biggs T, Georgescu M, Haro-Monteagudo D, Jewitt G, Ozdogan M, Marshall M, Thenkabail P, Daccache A and Marin F (2016). A sweet deal? Sugarcane, water and agricultural transformation in sub-Saharan Africa. *Global Environmental Change* 39:181-194.

Marin FR, Edreira JIR, Andrade J and Grassini P (2019). On-farm sugarcane yield and yield components as influenced by number of harvests. *Field Crops Res* 240: 134-142.

Lin W, Wu L, Lin S, Zhang A, Zhou M, Lin R, Wang H, Chen J, Zhang Z and Lin R (2013). Metaproteomic analysis of ratoon sugarcane rhizospheric soil. *BMC Microbiol* 13:1-13.

Liversage H and Jonckheere S (2014). Securing Livelihoods, Land and Natural Resource Rights through Inclusive Business Models: Lessons from Swaziland and Sao Tomé & Principe. In Annual World Bank Conference on Land and Poverty. The World Bank, Washington DC, March (pp. 24-27).

Swaziland Sugarcane Association (SSA), (2015). Integrated Annual Report 2014/2015, 5-33.