SHORT COMMUNICATION

IMPACT OF POLYMER ON THE SUGARCANE YIELD AND WATER USE UNDER SUBSURFACE DRIP IRRIGATION IN ESWATINI

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Abstract

The Eswatini Sugar Industry (ESI) has experienced severe droughts in recent years, due to climate change. The levels and availability of water have been reducing significantly, hence the need is growing daily to save and use water judiciously. In 2017, the Eswatini Sugar Association established a trial under subsurface drip irrigation system, in order to assess the impact of a water absorbent polymer (HiProAqua) in saving water, its effect on the pest and disease levels and on the sugarcane yield. The product was applied by hand once, at 60 kg/ha, in red clay, loamy soil, and it was covered slightly by soil before the cane setts (Variety N25) were planted. The trial used a randomised block design with two replications and four treatments. Treatment A (the control – without the polymer) was irrigated at 100% of the Total Available Water (TAW), and Treatments B, C and D (with the polymer) were irrigated at 80%, 60% and 50% of the TAW, respectively. The Canesched programme was used for the scheduling and water reports. Leaf and growth measurements and pest and disease surveys were conducted by using the ESI standards. The results showed no significant differences in the cane (TCH) and sucrose (TSH) yield among the treatments ($p>0.05$). On average, Treatment D achieved the highest water saving (21.1%), the highest yield (114.3 TCH and 19.9 TSH) and the highest water-use efficiency (10.3 tons cane/100 mm). No major pests or diseases were observed until the 4th ratoon, when Eldana appeared in Treatments B, C and D. However, there were no significant differences in the pest levels among the treatments. By using the polymer, the irrigation water that was applied was decreased, without negatively affecting the sugarcane yield.

Keywords: irrigation, trial, water, treatment, polymer, sugarcane

Introduction

The ESI is one of the key contributors to the Eswatini economy, accounting for about 6% of the country's Gross Domestic Product (ESA Integrated Annual Report, 2023). In recent years, the ESI has experienced a sharp increase in electricity tariffs and the occurrence of severe droughts. The effects of the drought have been a downward trend in the water levels and its availability, and it has resulted in low yields; hence, there is a need to always save and use water cautiously. One of the water-saving strategies is the use of soil modifiers, like polymers. In 2017, the Eswatini Sugar Association (ESA) established a trial to test the effectiveness of a polymer called HiProAqua in sugarcane production in Eswatini. HiProAqua is produced by a German company called HiProAgro. According to HiProAgro, HiProAqua is one of the Super-Absorber Polymers (SAPs) derived from a diabase primeval rock material. SAPs are compounds that absorb water and swell up to many times their original size and weight (Oraee *et al.*, 2013). They are said to increase the soil's shear strength, to improve its volume stability, to promote water retention and to prevent erosion (Almajed *et al.,* 2022).

The objectives of this trial were: (1) to evaluate the effects of the polymer on saving water under different water regimes; (2) to evaluate the impact of the polymer on the crop yield

performance and pest and disease levels; and (3) to evaluate the Water Use Efficiency (WUE) in each treatment. The trial was irrigated by a subsurface drip irrigation system.

Methods

Design and variety used

A randomised block design with two replications (due to some limitations) and four treatments was used for this trial, which had a 1.9 m row spacing, with the whole plot size of five rows being 70 m long. The breaks between the plots were 2 m, with 3 m end-effects in each row. Variety N25 was planted; it was selected based on its sensitivity to water stress and it being one of the dominant varieties in the ESI.

Treatments and water management

Treatment A (control – without the polymer) was irrigated at 100% of the Total Available Water (TAW), while Treatments B, C and D (with the polymer) were irrigated at 80%, 60% and 50% of the TAW, respectively. In the first year (plant cane), the application of water was not restricted in all the treatments, in order to encourage the establishment of a good crop. From the first ratoon onwards, water was applied, as per the treatments. An irrigation scheduling software programme (Canesched) was used to manage and analyse the irrigation events in this trial. The Gross Irrigation Application (GIA) for each treatment was compared to the control, in order to determine the amount of water that was saved (%).

Soil and polymer application rate

Application rates depend on the soil type. The HiProAgro company recommends 50-150 kg/ha. Polymers are applied underneath the soil where they can hold the water within the root system of the plant. This trial was planted in freely-draining red clay, loamy soil. The over-application of polymers cracks the soil; hence 60 kg/ha was used. HiProAqua is usually applied to other crops by using machinery. However, at the time, no machinery was available that was modified to apply this product in sugarcane. As a result, the product was applied by hand in the planting furrows in this trial, and it was covered slightly by soil before the cane setts were planted.

Standard procedures and data analysis

Soil sampling and fertiliser recommendations, weed control, leaf and growth measurements, as well as pest and disease surveys, were conducted according to ESI standards. The crop was harvested annually and the yield performance in Tons Cane per Hectare (TCH) and Tons Sucrose per Hectare (TSH) were measured at each harvest-time. The Analysis of Variance and Least Significant Difference (LSD) were used to analyse the collected data.

Results and Discussion

Irrigation water savings

There were no significant differences in the cane and sucrose yields between the treatments in this trial ($p>0.05$), yet the water saved ranged between 6.23% and 24.92% (Table 1). The highest water-saving was achieved in Treatment D (24.92%), and the least water was saved in Treatment B (6.23%). An increase in water saving (%) was observed from 2020/21 to 2022/23, due to the substantial annual rainfall received (ranging between 769-911 mm, which was above the long-term mean).

Water use efficiency

The WUE ranged between 6.7 to 13.5 tons/100 mm (Table 1). The five-year average showed that Treatment D had the highest average WUE (10.3 tons cane/100 mm), while Treatment A had the lowest WUE of 8.4 tons cane/100 mm. The five-year WUE average for all the treatments was similar to those observed by Thompson (1976) in sugarcane grown in lysimeters, which ranged between 8.3-17.2 tons cane/100 mm from selected sites in southern Africa.

Crop yield performance

There were no significant differences in the cane and sucrose yields between the treatments in this trial ($p>0.05$) and no data variabilities were observed (CV<12). The yields in the TCH ranged between 79.4 and 145.6, while those in the TSH ranged between 14.6 to 25.8 (Figure 1). The highest yields were obtained in the first ratoon. Treatment D (the highest water saved) obtained the highest average yield of 114.3 TCH and 19.9 TSH. The lowest yield performance was observed in Treatment A (99.1 TCH and 17.3 TSH), which had no water restrictions.

Pest and disease levels

No major pests and diseases were observed until the 4th ratoon (the 2021/22 season) where Eldana was first observed in Treatment D (maximum irrigation water reduction), in which 0.25% of the cane stalks were damaged. In 2022/23, Treatments B to D (with reduced irrigation water) were affected by Eldana. 1.31% of the sugarcane stalks were damaged by Eldana in Treatment B, 1.61% in Treatment C and 0.72% in Treatment D. However, there were no significant differences in the pest levels among the treatments. Throughout the trial, no Eldana damage was observed in Treatment A (with no water restrictions). This is because Eldana damage favours cane that is more prone to water stress (SASRI, 2005).

Conclusions

The results showed no significant differences in the TCH and TSH among the treatments ($p>0.05$), which indicated that the polymer (HiProAqua) had an impact. On average, Treatment D achieved the highest water-saving (21.1%), the highest average yield (114.3 TCH and 19.9 TSH) and the highest average WUE (10.3 tons cane/100 mm). No significant occurrence of pests or diseases was observed until the 4th ratoon, when Eldana appeared in Treatments B to D (with restricted water application), but there were no significant differences in the pest levels among the treatments. By using the polymer, the amount of irrigation water applied was decreased, without negatively affecting the sugarcane yield. However, there was no severe drought during the trial period; instead, there have been seasons with good rainfall. The trial will be terminated in the 2023/24 season (the 7th year) because, according to HiProAgro, the polymer is effective for about 3-4 years. Further studies can be carried out to determine the effect of the polymer on the sugarcane yield, when the water application is less than 50% of TAW, to determine the minimum threshold of water reduction.

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Table 1. Irrigation water report for each treatment in the respective growing seasons of the trial

Season	Treatments	Gross rainfall (mm)	Effective rainfall (mm)	Crop water use (mm)	Net irrigation (mm)	Supply / demand index (%)	Water Saved (%)	WUE (tons/ mm)
2018/19	Treatment A	447	231	1 130	891	101	0	11.64
	Treatment B	447	304	1 124	804	100	9.76	12.14
	Treatment C	447	325	1 103	757	99	15.03	13.20
	Treatment D	447	330	1 057	709	95	20.42	13.52
2019/20	Treatment A	454	242	1 133	885	100	0	7.67
	Treatment B	454	295	1 131	830	99	6.23	9.04
	Treatment C	454	319	1 113	788	98	10.97	9.79
	Treatment D	454	328	1 081	746	95	15.73	11.03
2020/21	Treatment A	773	282	1 220	907	98	0	8.12
	Treatment B	773	346	1 217	840	97	7.41	9.66
	Treatment C	773	392	1 177	756	96	16.66	9.77
	Treatment D	773	409	1 147	714	94	21.25	9.71
2021/22	Treatment A	769	420	1 190	763	100	0	6.67
	Treatment B	769	486	1 176	674	99	11.69	7.24
	Treatment C	769	530	1 163	615	98	19.43	6.85
	Treatment D	769	539	1 143	586	96	23.16	7.83
2022/23	Treatment A	911	337	1235	899	100	0	7.99
	Treatment B	911	409	1211	791	99	12.01	8.28
	Treatment C	911	431	1176	729	96	18.92	8.18
	Treatment D	911	439	1131	675	92	24.92	9.60

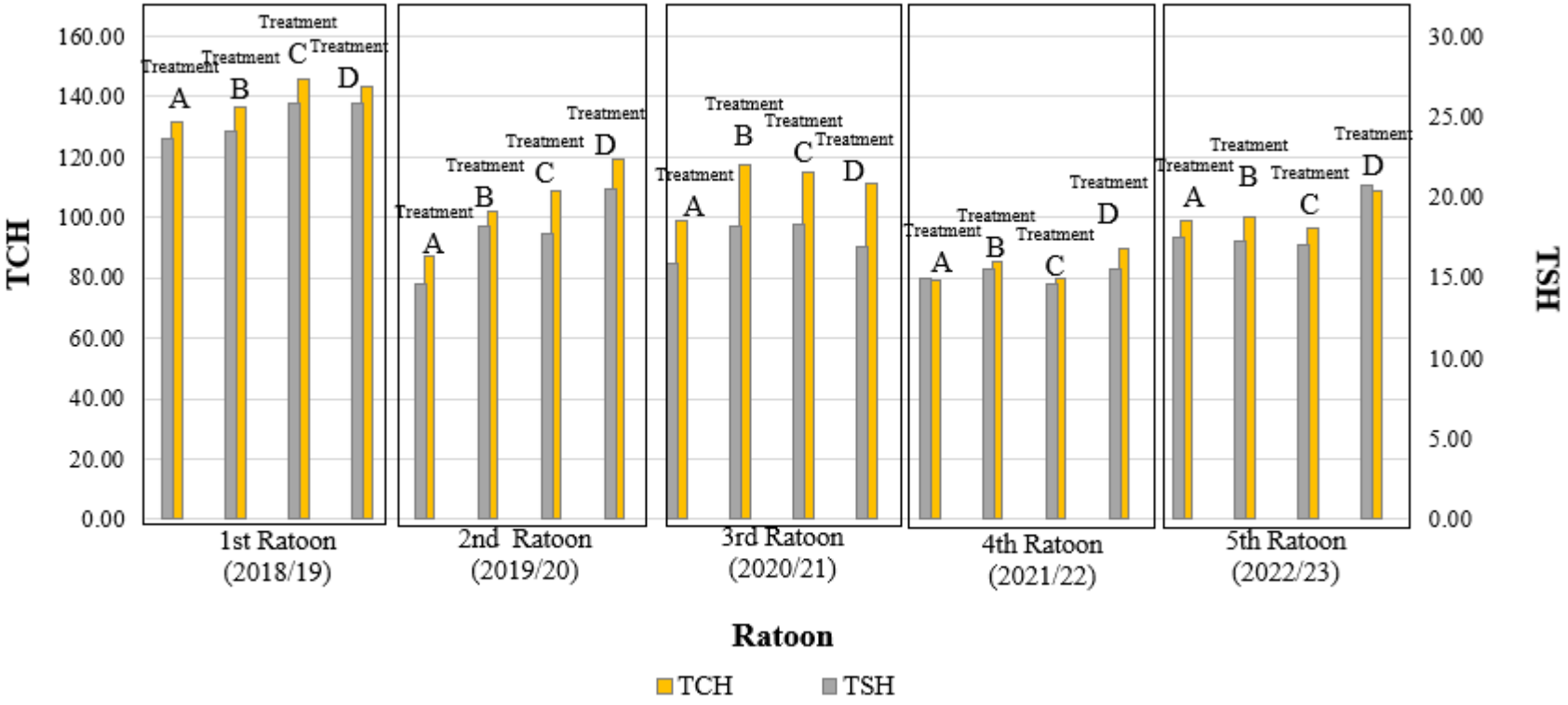

Figure 1. Yield performance (TCH and TSH) for each treatment at the respective ratoons