A COMPARISON OF YIELDS OBTAINED UNDER INROW AND INTERROW IRRIGATION METHODS AT MHLUME (SWAZILAND) SUGAR COMPANY

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Abstract

Studies conducted at Mhlume (Swaziland) Sugar Company on furrow irrigation have shown differences in water use efficiency between inrow and interrow irrigation methods. The yield advantages of inrow compared with interrow irrigation may differ between crops. The plant cane and first ratoon crops produce higher yields under inrow than interrow irrigation; however, there are no differences in the later stages of the ratoon cycle. The lower irrigation efficiency and detrimental effects of higher water applications under inrow irrigation have thus led to a proposal for conversion from inrow to interrow irrigation after the first ratoon.

Introduction

At Mhlume, inrow irrigation has been the standard practice in plant cane crops. The increased application and preferential placement of water directly above the seedcane has ensured a good germination rate. However, this method has a low irrigation efficiency (tons cane/mm water/hectare) compared with interrow irrigation and leads to a higher water use (Pearse and Gosnell, 1969). For this reason fields were converted after harvest of the plant crop to interrow irrigation. This method uses less water but delivers it to an area further from the main root zone. In the particularly poor soils at Mhlume there is very little lateral movement of water. Therefore in some instances the soil under the stool was relatively dry even after recent irrigations, and water stress symptoms were more quickly evident. In 1987, in an attempt to reduce drought stress in ratoon crops, a change to inrow irrigation was made for all crops on these soils. In this paper, commercial yield results from inrow and interrow irrigation methods are compared, with a view to making recommendations as to which method is better.

Method

Correction factors

The yield data chosen for this study were from fields harvested at different ages, stages in the ratoon cycle, harvest dates, and years. To compare yields from the two methods, correction factors were required to remove some of the initial variation. A series of correction factors (Appendix 1) were calculated using a system devised by Sweet and Patel (1985) but included yearly and ratoon cycle correction factors not previously mentioned. This system calculated correction factors on the basis of mean yields and a standard to which these yields could be corrected. For the ratoon stage, yields were corrected to a ratoon 2,428 equivalent, as this was the mean ratoon number for the sample used in the calculation of the correction factors. The yearly correction factors were calculated on the basis of annual mean tc/ha from the whole estate and corrected to a standard of 100 tc/ha. Age at harvest was corrected to a 12-month old equivalent yield and May was taken as the standard month of harvest. For any correction factor the calculation was similar. The means were calculated under the various allotments and a standard month of harvest, age, etc. chosen. The yield of this standard was divided by the yield of the particular allotment to give the correction factor. The correction factors for age at harvest were then analysed by month to give the line of best fit and correction factors calculated from these lines. A similar regression (for stage in the ratoon cycle) was made from the data. Seasonal and yearly correction factors were not altered by regression as a linear relationship was not expected.

Yield comparison

Yield data were collected from field records of previous years (1982-1991) harvests. These data came exclusively from the poorer H and Z duplex soils under furrow irrigation (Murdoch, 1972). The yield characteristic chosen was tons cane/hectare/month (tc/ha/m) of the variety NCo376.

From 1982 to 1987 all ratoon crops were interrow irrigated, and from 1988 to 1991 most fields were inrow irrigated. Two comparisons were made between the irrigation methods. The first was between interrow and inrow yields from 1982 to 1991, and the second was between the two irrigation methods in 1988, when sufficient numbers of fields under each irrigation method to ensure a meaningful comparison were available within the same year. Both comparisons were necessary due to the change in the irrigation methods used at Mhlume. The first comparison gives the largest sample size but relies on comparisons of the two methods operating in different years to each other, and thus requires the use of accurate correction factors. In 1988 these methods could be studied together in the same year, thus removing this variation. Data were compared using the F-test on variances and the t-test on means, to check for any significant difference.

Cane yields from 1982-1991

A sample of 44 blocks, approximately 222 fields, were studied and tc/ha/m yields compared for the two irrigation methods. Ratoon crop fields between 1982-1987 were irrigated in the interrow and their yield compared with those from inrow irrigated fields during 1987-1991. Ratoons were compared with each other directly to see if any influences of irrigation method on yield were found in the different ratoons. Plant cane was not grown under interrow irrigation and could not be compared in this study.

Comparison of yields in 1988

Yield data were collected from field records and tc/ha/m values calculated. For this study 17 blocks each of inrow and interrow were compared. The inrow yields were all from plant and first ratoon cane which had been planted inrow or left inrow following the 1987 irrigation policy decision. The interrow blocks were from first, second, third and fourth ratoons which were converted to interrow before 1987.

Results

Yield comparison

In the first yield comparison the raw data (tc/ha/m) showed that slightly higher yields were achieved in ratoons one, two and three for the inrow irrigated fields, by 0,5, 0,3 and 0,6 tc/ha/m respectively (Table 1). However, these differences were not statistically significant.

Table 1

Raw data - tc/ha/m

Irrigation system	Ratoon number	Mean tc/ha/m	Standard error
	1	7,856	0,207
Interrow	2	7,397	0,178
(1982-1986)	3	7,382	0,297
	1	8,373	0,204
Inrow	2	7,704	0,245
(1987-1991)	3	7,952	0,339

After correction of the data to produce the corrected tons tc/ha/m, only the first ratoon achieved a higher yield for inrow irrigation (Table 2). Again this difference was not statistically significant.

Table 2

Corrected data - (tc/ha/m)

Irrigation system	Ratoon number	Mean corrected tc/ha/m	Standard error
	1	7,952	0,216.
Interrow	2	7,760	0,231
(1982-1986)	3	7,710	0,308
	1	8,422	0,182
Inrow	2	7,554	0,235
(1987-1991)	3	7,722	0,260

In the comparison of yields from 1988, similar results were obtained (Table 3). For the raw data, inrow yielded higher by 1,9 tc/ha/m, a statistically significant difference. However, after correction in the two samples, it was found that no significant difference remained between yields from the two irrigation methods.

Table 3

Comparison of interrow vs inrow - 1988

Irrigation system	Yield	Mean	Standard error
Interrow	tc/ha/m	5,973	0,148
	corrected tc/ha/m	6,592	0,243
Inrow	tc/ha/m	7,854	0,280
	corrected tc/ha/m	6,744	0,200

Despite the lack of significance in the differences in yield, a consistently higher yield was obtained for the first ratoon crops irrigated on the inrow.

Discussion

The results of this study show that a difference in yields from the two systems was present. The inrow irrigation method resulted in higher yields in the first ratoon, but not in the later ratoons. However, the accuracy of the comparisons of corrected tc/ha/m figures was dependent on the correction factors. The need to correct for year of harvest (Appendix 1) in the first comparison of the two irrigation methods was a problem as the yearly average tc/ha/m, from which the correction factor was calculated, will have been affected by many factors other than climate. Management policies relating to, for instance, fertilizer and irrigation have changed greatly over the period of the study. The effects of these changes may be incorrectly attributed to climatic factors, therefore this correction factor is made somewhat inaccurate. The different years may therefore still have had an effect when the populations were compared. In the first comparison of raw data, the inrow sample came from later years and could have benefited from constructive developments in the crop production system. Yield comparisons were also biased towards inrow irrigation in the raw data as younger ratoons, and thus higher yielding crops, made up a greater part of the inrow sample. In the second comparison, yields were taken from different ratoon crops to represent the two irrigation methods with inrow being from the higher yielding plant and first ratoon cane.

Despite these problems, previous work conducted at Mhlume supports the results. A replicated trial (Ndlovu, 1991) was conducted to compare the two furrow irrigation methods (Appendix 2). Cane yields and water use were compared. In the first ratoon, inrow yielded about 10 tc/ha more than interrow; however this improvement was not statistically significant. In the second ratoon there were no differences in yield. Sucrose % was the same for both irrigation methods; thus a higher tons sucrose per hectare could also be expected for inrow irrigated crops. A comparison of water use between the two methods showed 66% more water was effectively applied under inrow irrigation (Figure 1).

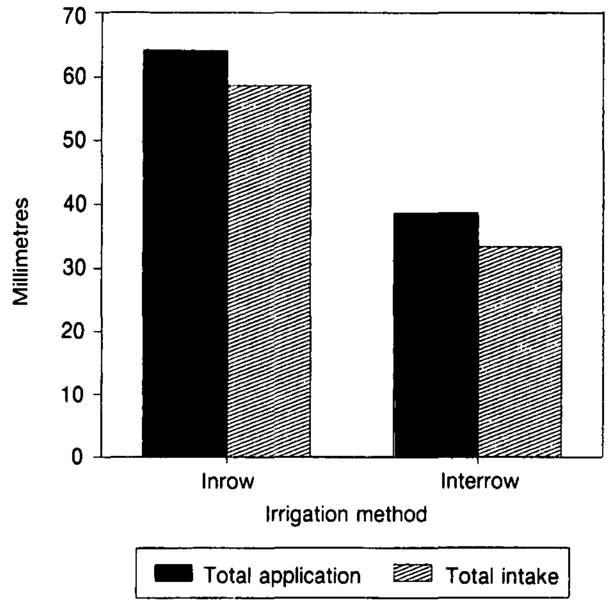

FIGURE 1 Water application

The soil moisture content on the stool, as shown in Figure 2, was also higher for the inrow irrigation method. Although the soil moisture contents on the ridge and furrow are similar for both irrigation methods, the inrow cane is situated in the furrow and thus has more available soil water than the interrow cane on the ridge.

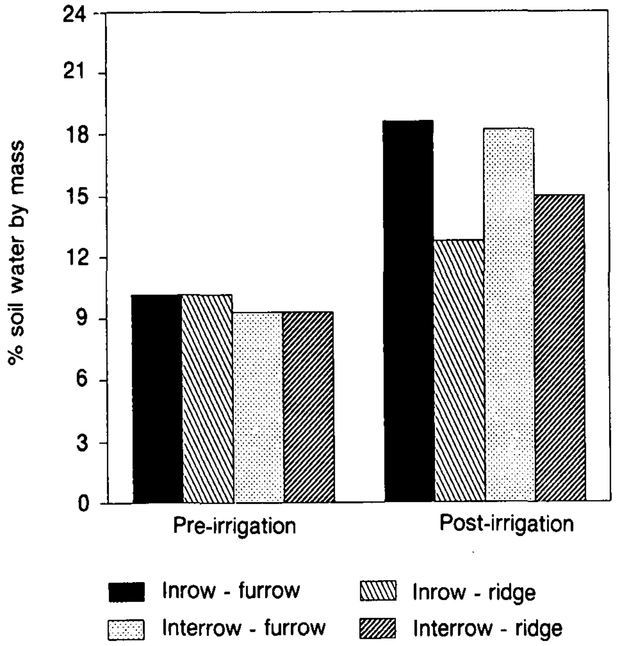

FIGURE 2 Soil moisture content

In another study at Mhlume, plant cane yields from inrow and interrow irrigation methods at different furrow gradients, more suited to the irrigation method, were compared (Appendix 3). Again yields of plant cane were higher for inrow by about 9 tc/ha, but were not significantly different (unpublished data).

The initially good soil structure in the ratoon cycle enables larger amounts of water to be used or stored in the soil without waterlogging or ponding. The lack of a similar response to extra water in the second and subsequent ratoons may be associated with the sharply deteriorating structure of the soils (Workman *et al.*, 1986). This deterioration could be due to lower infiltration rates and soil water contents under both the inrow and interrow irrigation. As the water holding capacity of the soil declines, the extra water applied with inrow irrigation is probably causing waterlogging and suppressing yields, thereby losing the benefits shown previously. This extra water is difficult to control in the field as it is slower moving within the row due to resistance and cannot be applied efficiently by a cutback irrigation method. Higher water application rates under inrow irrigation may be expected to lead to a greater number of salinity and sodicity problems in the long term, if the method of irrigation remains inrow for all ratoons. Therefore, as benefits in yield are not seen in any but the plant cane and first ratoon crop, the recommendation for furrow irrigation at Mhlume is for inrow in these first two stages of the ratoon cycle and interrow irrigation for the later stages, a change from the current inrow irrigation in all ratoons.

Conclusions

The conclusions from this study were that the continual use of inrow irrigation in ratoon crops is not advisable. There is no increase in cane yields from the second ratoon onwards, despite much higher water application rates. Higher application rates may lead to a number of problems:

- Ponding and waterlogging
- Increased salinity and sodicity where poorly drained
- Increased runoff and erosion
- Longer irrigation cycles
- Damage in fields insufficiently dried off at harvest
- Higher water costs
- Higher labour costs

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APPENDIX 1

Yearly correction factor

	Year	tc/ha	CF
	91	102,11	0,98
	90	98,62	1,01
Inrow	89	91,90	1,09
95.317	88	88,64	1,13
	87	96,62	1,04
	86	104,44	0,96
	85	85,85	1,16
Interrow	84	105,80	0,95
96.027	82	87,42	1,14

Age at harvest correction factors (AHCF) to convert yields to a 12 month age equivalent

Month of harvest

Age	April	May	June	July	Aug	Sept	Oct	Nov
10,50	1,03	1,22	1,08	1,01	1,05	1,04	1,08	1,07
11,00	1,02	1,14	1,05	1,01	1,03	1,03	1,05	1,05
11,50	1,01	1,06	1,03	1,00	1,02	1,01	1,03	1,02
12,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
12,50	0,99	0,94	0,98	1,00	0,98	0,99	0,98	0,98
13,00	0,98	0,89	0,95	1,00	0,97	0,97	0,95	0,96
13,50	0,97	0,85	0,93	0,99	0,95	0,96	0,93	0,94

Season at harvest correction factors (SHCF) to convert yields to a May equivalent

Month of harvest

	May	June	July	Aug	Sept	Oct	Nov
Tc/ha/m	9,09	9,75	9,81	9,86	9,05	8,95	8,13
SHCF	1,00	0,93	0,93	0,92	1,00	1,02	1,12

Crop stage correction factors (CSCF) to convert yields to an equivalent of crop stage 2,428

Ratoon cycle	tc/ha/m	CF
1 PL	8,26	0,94
2 R1	7,93	0,98
3 R2	7,59	1,03
4 R3	7,26	1,07
5 R4	6,92	1,12
6 R5	6,59	1,18
7 R6	6,26	1,24
2,428 R1,428	7,78	1,00

APPENDIX 2

Field 403/2 - Irrigation trial

Irrigation system	Ratoon Number	Mean tc/ha
Inrow	1	90,48
	2	93,17
Interrow	1	80,98
	2	92,68

APPENDIX: 3

Field 201/2 - Irrigation trial

Irrigation system	Gradient	Mean tc/ha
Inrow	1:150	137,25
	1:200	136,49
Interrow	1:250	129,47
	1:300	125,52

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