FURROW IRRIGATION EVALUATION

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Abstract

Intake rates varied considerably on the same soil when various factors affecting intake rate were implemented. These factors are all variable and must be considered in the design and management of an efficient furrow irrigation system.

Introduction

Our ability to improve our surface irrigation efficiencies is limited by the fact that we do not know how much the following factors are interrelated, and how much alterations to them affect the amount of water applied. In designing a surface irrigation layout, the important factors which have to be considered are:—

(*a*) Soil texture and depth which determine the amount of water which can be applied at any one irrigation without loss to deep percolation.

(*b*) The topography of the area which determines to a large extent the gradient and length of line.

(*c*) The shape of furrow which determines the contact area, which in turn determines intake rate.

(*d*) The irrigation stream flow rate in the furrow which influences the choice of grade, furrow length and furrow shape.

(*e*) The age of the crop also has to be considered. With increasing age we have increasing trash in the furrow, which together with lodging, can change the intake rate considerably.

Any one or combination of the above factors can be limiting and they therefore will determine the optimum implementation of the others in order to obtain the most efficient layout.

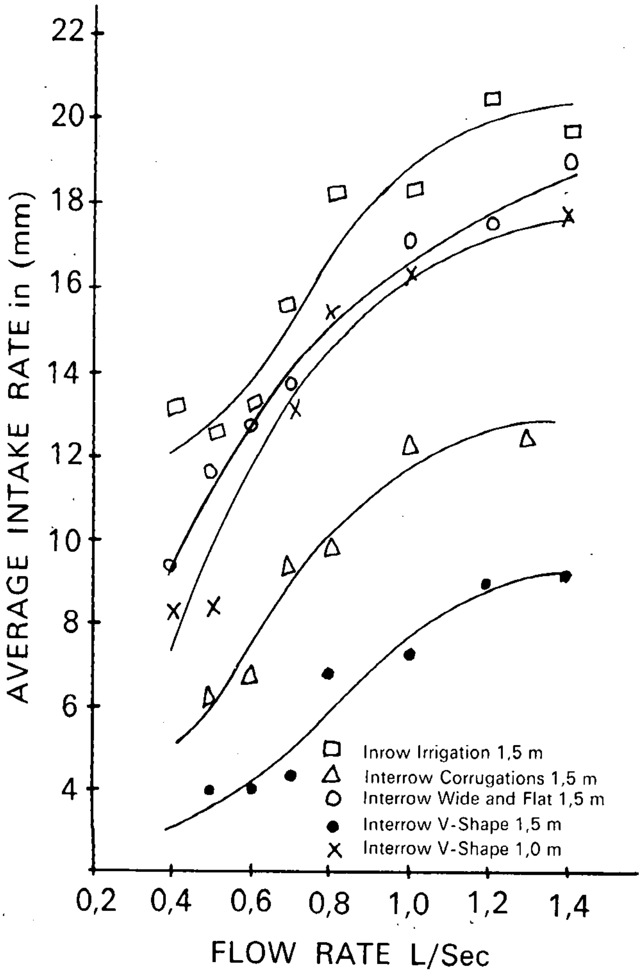

FIGURE 1A: The effect of flow rate and furrow shape on intake rate — Plant crop.

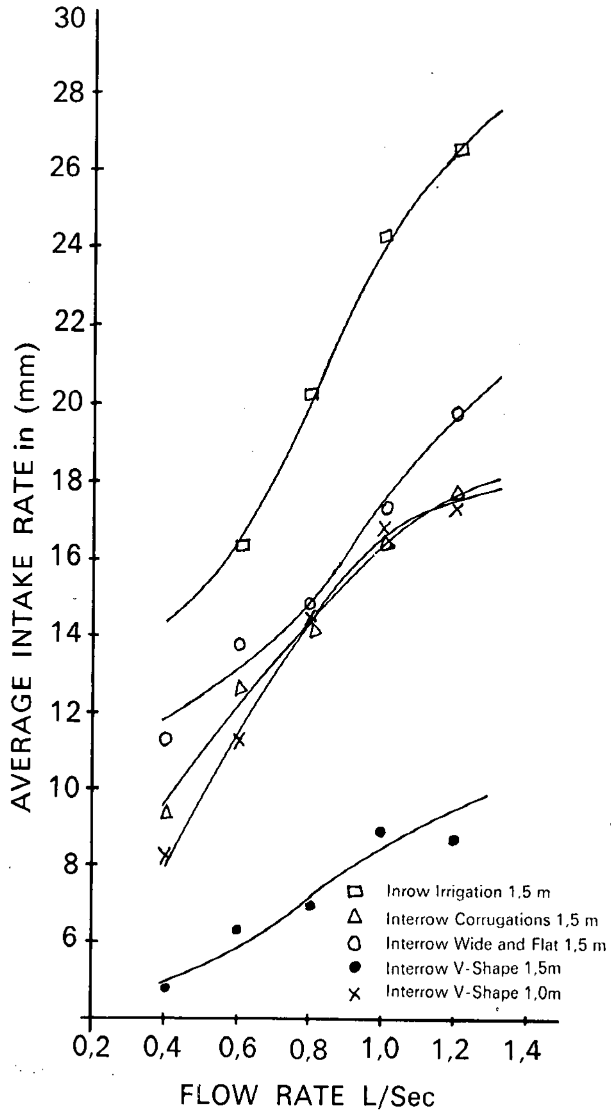

FIGURE 1B: The effect of flow rate and furrow shape on intake rate — 1st ratoon.

Experimental Layout

Furrow intake rate is the controlling factor in the design of any furrow irrigation scheme. Coupled with the duration of irrigation water contact with the furrow, which is determined by the advance and recession of the stream, the correct length, gradient and shape of furrow can be determined.

A trial was started on the Experiment Station in September 1971 with the object of trying to cover as many of these factors as possible. The experiment was established on a P E 1 sandy-clay-loam, which averages in depth about 60-80 cms and overlies well weathered paragneiss. This soil is representative of about 60% of the soil currently under sugarcane production in the Rhodesian Lowveld.

After the minimum amount of soil movement in land levelling and land preparation had been done, four blocks 54 metres square were laid out. Each block represents a separate grade, these being 1:400, 1:200, 1:100 and 1:50.

Each of the blocks was split into ten four-row plots. These ten plots were split into two replications of five different furrow profiles. Three of the profiles were representative of those currently used in the Lowveld. They were:—

(*a*) Inrow; down the cane line irrigation at 1,5 metre row spacing.

(*b*) Interrow; with a wide flat bottom at 1,5 metre row spacing.

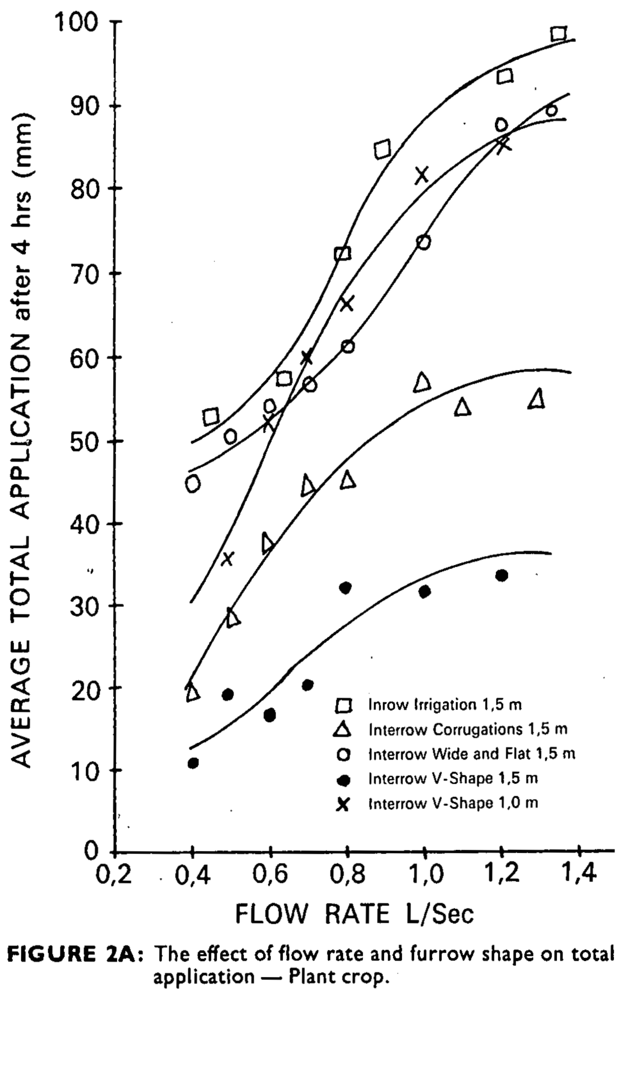

FIGURE 2A: The effect of flow rate and furrow shape on total application — Plant crop.

(*c*) Interrow; with a deep V-shape profile, also at 1,5 metre row spacing.

The two other profiles were put in because they appeared to meet some requirements not adequately met by the previous three. They were:—

(*d*) Corrugation interrow; two small furrows were placed in the interrow between the rows of cane. Row spacing at the standard 1,5 metres.

(*e*) Narrow interrow; the same as the deep V-shape but with the cane row spacing decreased from the standard of 1,5 metres to 1,0 metre.

The other variable which was applied to the trial was a variation in the furrow stream flow between 0,4 litres per second and 1,4 litres per second. Depending on the gradient, there was a limit to the maximum flow that could be applied to the furrow without causing excessive erosion.

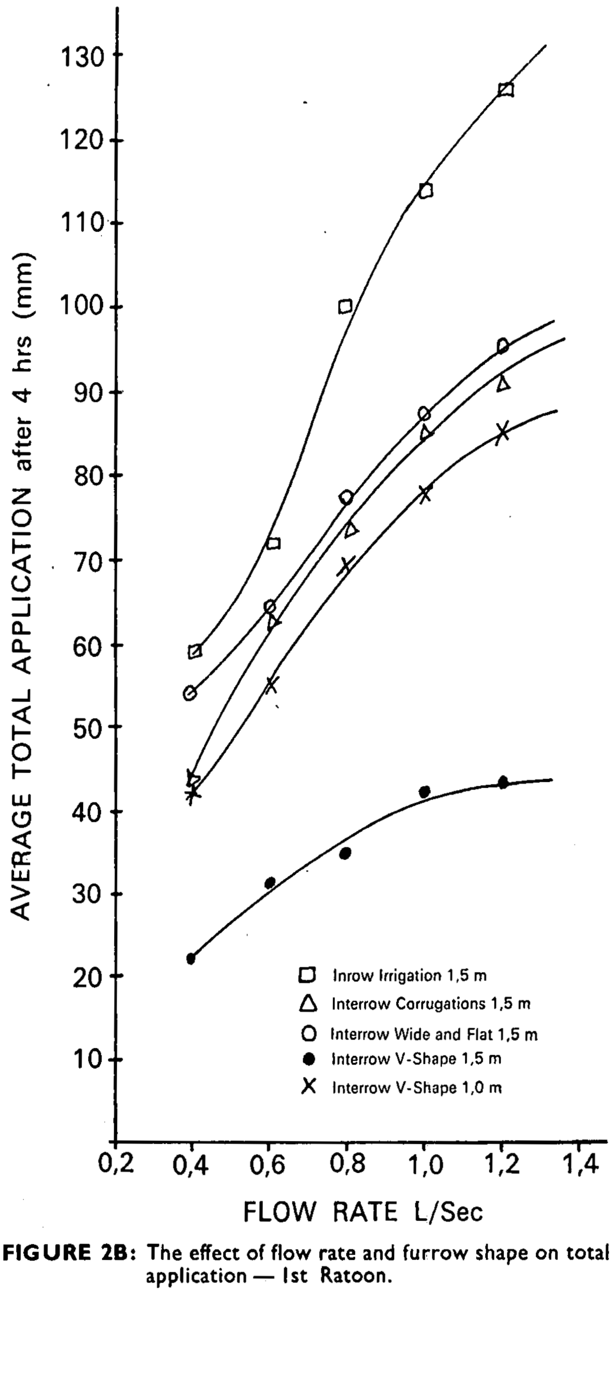

FIGURE 2B: The effect of flow rate and furrow shape on total application — 1st Ratoon.

Measurement

Determination of the furrow intake rate was calculated by the standard technique[2] of measuring the difference in water flow between two points in the furrow.

In order to maintain a constant flow of water into the head of the furrow during the test period, a free flow orifice box with a device to adjust the head of water was used. The outflow over the test length was determined by using a portable Washington State College measuring flume.

Each plot was on a separate schedule, and throughout the entire cropping period the schedule was based on 100% of Class 'A' pan. Each plot was irrigated for 4 hours irrespective of varying rates of application. The irrigation control was done in this manner to ensure ease of management in running the experiment.

Further measurements are being taken, but the data have not yet been processed; and, at this time their effects could not be accurately determined. They are:—

(*a*) The time of advance and recession of the stream along the furrow.

(*b*) The antecedent soil moisture before each irrigation.

(*c*) The velocity of water flow in the furrow, and its effect on the erodibility of the soil.

(*d*) The wetting pattern of the applied water in the soil profile, and its effect on the distribution of the roots.

Results and Discussion

The plant crop was harvested at the end of April, 1972[1]. The most striking data collected were those relating to intake rate and the total application after four hours of irrigation. The following graphs from the plant and 1st ratoon crops indicate the large differences between the various treatments.

Figures 1a and 1b clearly show the effect on the intake rate, (in mm per hour), of the various furrow shapes over a range of stream flow rates. The intake rate on any one furrow shape was almost doubled with an increase in stream flow rate from 0,4 to 1,4 litres per second. The effect of furrow shape on intake rate can be seen by taking a constant flow rate. There was a threefold increase from the 1,5 metre V-shaped interrow irrigation to the inrow irrigation. The combination of both stream flow rate and the five furrow shapes resulted in a variation in intake rate from 3 mm per hour to 20 mm per hour (Figure 1a), and 5 mm per hour to 28 mm per hour (Figure 1b).

Figures 2a and 2b illustrate total application in mm after 4 hours of irrigation. The data were arrived at without reference to figures 1a and 1b and show

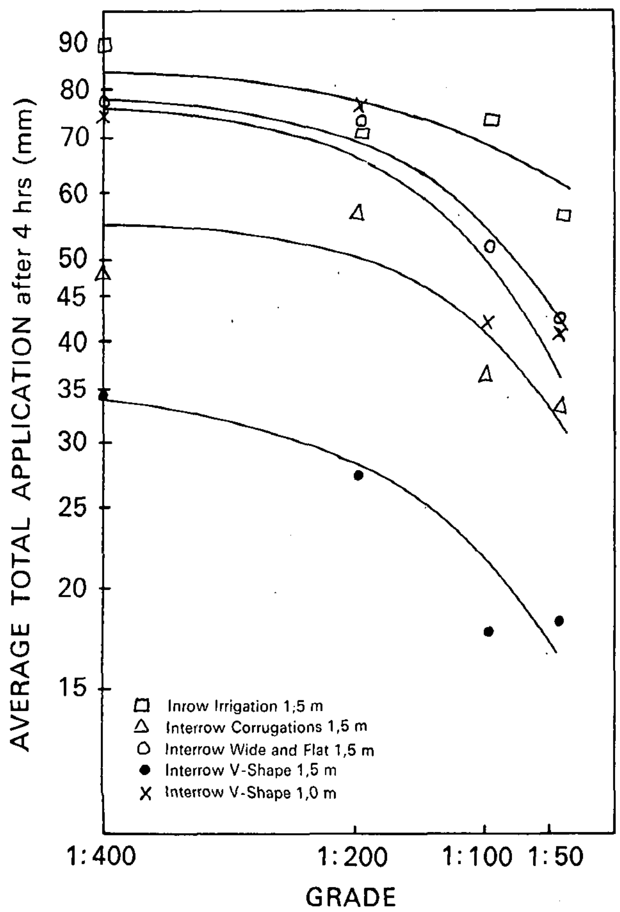

FIGURE 3A: The effect of grade and furrow shape on total application — Plant crop.

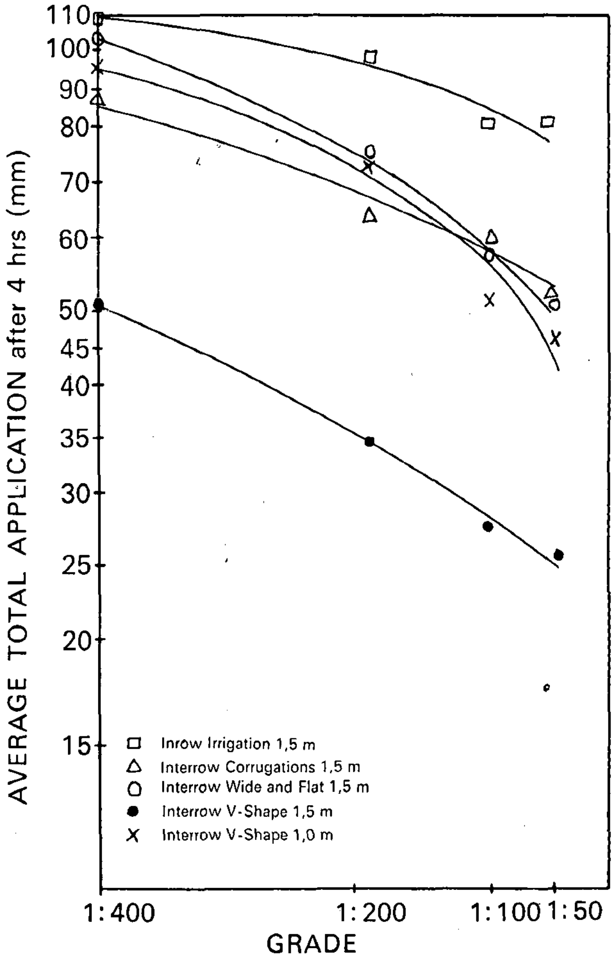

FIGURE 3B: The effect of grade and furrow shape on total application — 1st ratoon.

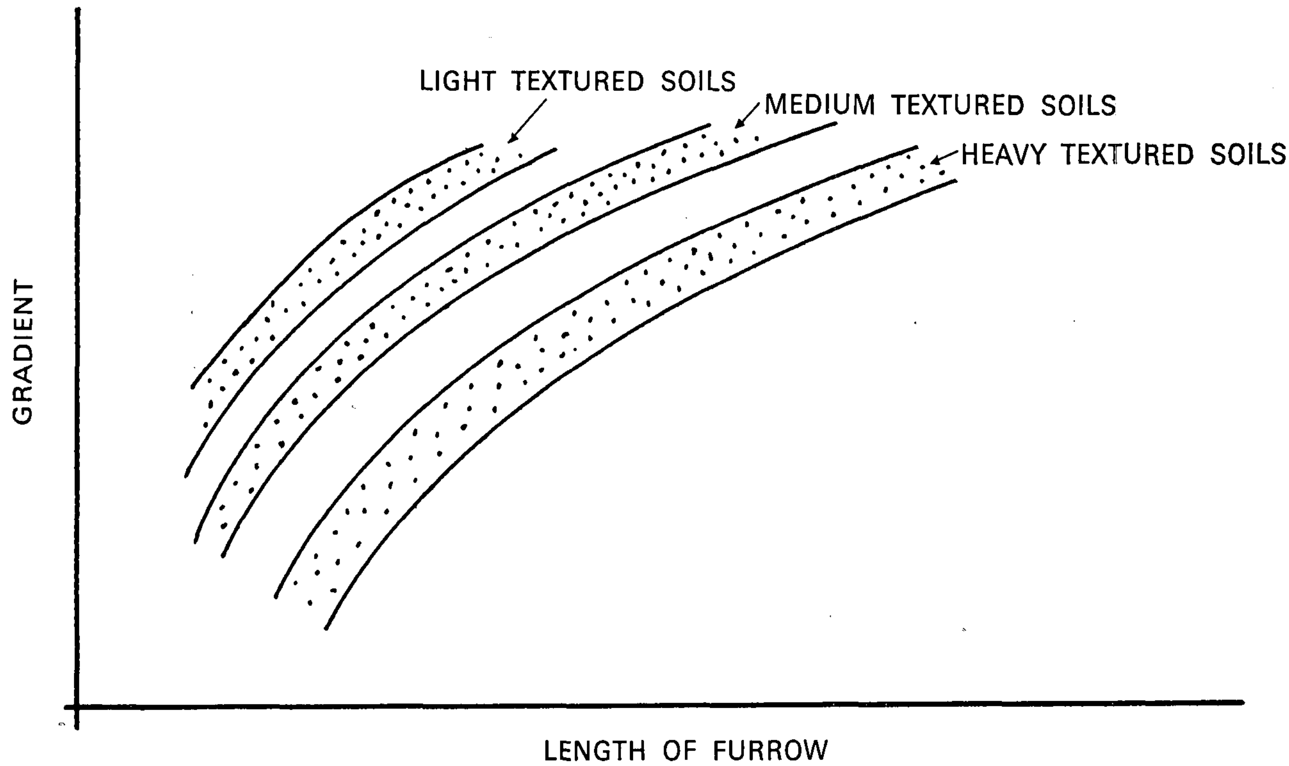

FIGURE 4: Hypothetical graph of optimum gradient for length of furrow for different soils.

clearly the close adherence to the intake rate values. The total application (in mm) in figures 2a and 2b show a greater than fourfold increase compared to the intake rate values in figures 1a and 1b. This could be expected from the intake rate, in mm per hour, which accounted for the fourfold increase after 4 hours. The excess is due to the higher intake rate which always occurs in the first few minutes of an irrigation. In figures 1a, 1b, 2a and 2b, the data are meaned over all gradients. The effect of increasing stool size in the inrow treatment can be seen with a marked increase in the first ratoon compared with the plant crop.

Figure 3 shows the effects of gradient on total application for the five furrow shapes. These values were averaged over all stream flow rates. This figure shows that changing the grade from 1:50 to 1:400 resulted in the total application being doubled. On any one gradient the variation across the five furrow shapes can be clearly seen with an almost threefold effect on total application. By combining both gradient and furrow shape the extemes are from about 15 mm to 85 mm after 4 hours of irrigation (Figure 3a) and from 25 mm to 120 mm (Figure 3b).

Conclusions

There is obviously a need to determine more accurately the effects of different management variables on the furrow irrigation of sugarcane. It is hoped that by enlarging upon the data obtained already it will be possible to give guidelines for more accurate control and management of furrow irrigation systems. A hypothetical representation of the data could finally be presented in the form shown in Figure 4. It is not known at present how best to use the variables but the application of them will no doubt depend upon the circumstances prevailing.

REFERENCES

1. Pearse, T. L., 1972. Furrow Irrigation Evaluation. Sugar News, No. **18**, 5.
2. Shockley, D. G.; Criddle, W. D.; Davis, S.; and Pair, C. H., 1956. Methods of Evaluating Irrigation Systems. U.S.D.A. Handbook no. **82**, 4.