IMPROVING THE IRRIGATION EFFICIENCY OF BURDEKIN CANEGROWERS

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Summary. A participatory action learning process has been used to encourage canegrowers to adopt irrigation scheduling through use of evaporation mini-pans and more efficient irrigation practices. Growers are encouraged to collect data on crop growth rates and water use. This enables them to better understand the responsiveness of the crop to soil moisture and identify the presence and magnitude of irrigation inefficiencies. Adjustment practices to improve irrigation performance are then identified and evaluated by the growers. This process has provided the cooperators with ownership of the information, improved the credibility of the results according to other growers, and enhanced the transferability of the adjustment practices between growers. Improvements in irrigation scheduling with evaporation mini-pans have resulted in a 10% increase in yield on some farms while a 10-47% reduction in water usage has been identified in other areas. The local industry will benefit by over $11 million annually through the wider adoption of these practices.

INTRODUCTION

Nearly 40% (182,750 ha) of the Australian sugar industry utilises either supplementary or full irrigation (1). Australian sugarcane production is rapidly expanding with the greatest increase occurring in the Burdekin district of north Queensland. The area currently produces 25% of the Australian production from 60,000 ha which is almost exclusively furrow irrigated.

Sugar cane yields in the Burdekin average around 124 t cane/ha. Although these yields are well above the state average of 90-100 t cane/ha, they represent only half of the potential yield for this environment (3). While these depressed commercial yields are probably a consequence of a number of factors, it appears that inappropriate irrigation strategies are one of the main constraints to achieving maximum production in this area. Kingston (2) has shown that water use efficiencies (WUE) of 13 t cane/ML are achievable in field trials. However, under commercial conditions this level is seldom reached. In the newly expanded lands of the Burdekin River Irrigation Area (BRIA), WUE of 8-12 t cane/ML of irrigation water are being achieved. BRIA soils comprise mainly hard setting cracking clays and sodic duplex soils. In the more freely drained soils of the traditionally farmed Burdekin Delta, only 3-8 t cane/ML is achieved. Soils of the Burdekin Delta vary enormously from coarse deep sands to friable clay loams. This reduced productivity has been attributed to both a lack of appropriate irrigation scheduling and application practices (5). Despite recent research to identify more efficient and sustainable irrigation practices, growers have been slow to adopt new technology.

Historically, irrigation scheduling has not been well accepted by Burdekin canegrowers despite a considerable extension campaign. In one program, growers were encouraged to schedule irrigations using a water balance chart system. Unfortunately, growers found these charts difficult to use, especially for those with limited education. The use of imprecise estimates of soil water holding capacities and effective rooting depths also led to predictive inaccuracies and a lack of confidence in the system. Growers in the Burdekin generally apply between 0.6 and 2.1 ML/ha irrigation, which is generally more than the root zone soil moisture deficit that is recharged by the irrigation (0.5-1.1?ML/ha). This high water use has been attributed to inadequate grower knowledge about the interaction between crop water use, soil-water properties and irrigation practices. Furthermore, in the Burdekin Delta, the majority of irrigation water is unmetered and growers are unaware of their water usage with some applying in excess of 25 ML/ha/year during recent low rainfall years.

To encourage the adoption of more efficient irrigation management practices, the Bureau of Sugar Experiment Stations (BSES) has embarked on a program of participatory action learning for growers. Since 1994, irrigation scheduling and water metering facilities have been provided to growers to identify for themselves the presence and magnitude of irrigation inefficiencies and to evaluate alternative practices. This paper reports on the operation and results of the participatory action learning process as a tool for grower adoption of improved irrigation technology.

MATERIALS AND METHODS

Meetings comprising 6-15 growers were conducted in 1995 at 16 locations (9 in the Delta and 7 in the BRIA), where a key grower had usually been involved in earlier irrigation studies with the BSES. The meeting was initiated by the key grower who was asked to invite the participation of neighbouring growers. At the meeting, growers were introduced to basic irrigation concepts such as soil water holding capacities, plant water use and infiltration processes. The importance of irrigation scheduling was highlighted and the evaporation mini-pan presented as a simple technique for scheduling. Growers were shown how to calibrate their individual mini-pans by measuring the height of 25 cane stalks to the top visible dewlap. In this technique, the mini-pan is filled to simulate the soil being at field capacity (as it should under furrow irrigation) immediately after an irrigation. Stalk heights are then taken to record the daily growth rates and to observe when the growth rate falls to 50% of the maximum observed. At this point, the depth of water evaporated from the mini-pan is noted and becomes the mini-pan deficit figure for that block. Evaporation mini-pans and measuring sticks were available at each meeting for growers to take free of charge.

The water balance results of typical irrigations conducted on different soils and using various management practices were also presented at the meeting. The data highlighted inefficient practices and stimulated considerable discussion and debate. Growers were subsequently encouraged to measure water use on specific blocks using BSES supplied portable 200 and 250mm flow meters that could be inserted into the layflat irrigation fluming. In particular, growers were encouraged to use the meters to identify differences in water usage with soils, cultivation and management practices. Growers conducted all field measurements for both the mini-pans and water meters on their farms.

RESULTS AND DISCUSSION

Irrigation scheduling

Over the 1994/95 summer, more than 50 cane growers collected their own crop growth rate data in order to calibrate an evaporation mini-pan for their soils and varieties. Generally, crop growth rates were found to reach a maximum 4-7 days after cessation of irrigation (Fig. 1) and only maintained maximum rates for 1-3 days, depending on the soil. Maximum growth rates of up to 48 mm/day were recorded for Q127, 44 mm/day for Q96 and 38 mm/day for the Q117 variety. The calibration procedure was found to reinforce the concept of readily available soil moisture with significant differences found between the mini-pan deficit figures for each soil type.

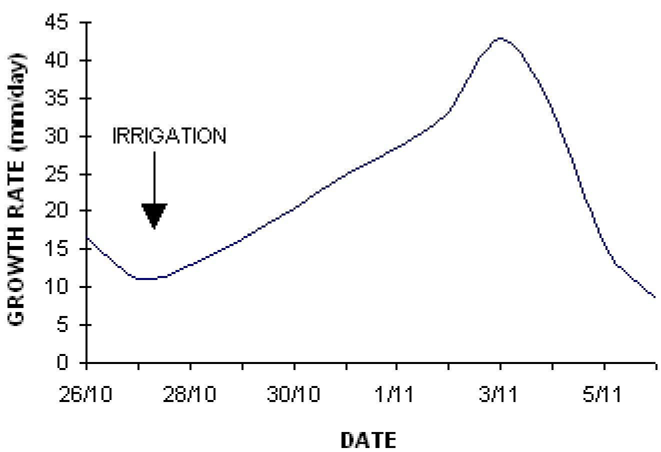

Figure 1. Typical crop growth rates after irrigation of an early plant Q96 crop.

In the Burdekin Delta, mini-pan deficit figures varied from 50 mm for the sands to 120 mm on the clay loams. The cracking clay soils of the BRIA had mini-pan deficits of 110-120 mm, whilst the deficits for the sodic duplex soils ranged from 60 to 110 mm. In some areas, the introduction of evaporation mini-pans produced a 10-15% yield increase for the 1994 harvested crop when compared to the previously unscheduled crop. The involvement of the growers in measuring sugar cane growth rates, and in conducting the mini-pan calibrations, has also provided them with a better understanding of the way their crop responds to irrigation, rainfall and other environmental factors.

Irrigation water usage

During the late summer period, fully grown crops (over 3 m tall) were monitored with water usage varying from 1.1 to 3.5 ML/ha/irrigation and irrigation efficiencies of 17-64%. Losses were attributed to both deep drainage and tailwater runoff depending on the soil, block design and management practices. Significant increases in water usage have also been attributed to cultivation practices. Irrigations conducted either on uncultivated sites or immediately after planting have been found to require an average application of 1.3 ML/ ha. However, irrigations applied after cultivation have required an average application of 2.8 ML/ha due to increased infiltration and deep drainage losses. On highly permeable soils, there is also some evidence to suggest that altering furrow shape may considerably reduce deep drainage losses (4). At one location, the average water applied in each irrigation was reduced from 1.99 to 1.06?ML/ha by modifying the traditional broad based furrow shape to a narrow based shape. It appears that the additional compaction associated with the formation of the narrow furrows was the major cause of the reduction in infiltration. This concept has been further developed and is currently being trialled on several other farms.

Benefits of improved irrigation management

The participative action learning process has been a useful technique to encourage grower adoption of more efficient irrigation practices. This process appears to be well accepted by growers with over 130 mini-pans distributed in the Burdekin area during the 1994/95 irrigation season alone. Currently twelve water meters are on loan to growers to help them assess the efficiency of both their current irrigation practices and adjustment practices. By encouraging growers to collect their irrigation scheduling and efficiency data, growers were found to perceive a degree of ownership over the data which helped reinforce the benefits of using these techniques. It also provided the data with a degree of grower credibility, which enhanced the transferability of the results and adjustment practices between growers.

Increased adoption of more efficient irrigation practices through this program is expected to both increase productivity and reduce water wastage. Productivity gains through better irrigation scheduling across the entire Burdekin, are conservatively estimated to be in the order of 10% on one third of the total sugar cane cropped area. With an average production in the Burdekin of 124 t cane/ha, this represents an increase of 12 t cane/ha over 20000 ha or 240000 t. The full current value to both millers and growers of this extra production is in excess of $10 million annually.

The economic significance of reducing water wastage by a modest 10% on one third of the Delta area equates to a savings of 2.5 ML/ha on 13,000 ha or 32500 ML. This volume is approximately 12.5% of the total quantity of water pumped by the South and North Burdekin Water Boards and represents a saving of approximately $450000. Growers also benefit directly by not having to pump the additional water. This reduction in water pumping and maintenance costs represent a saving of around $50 ha or $650000 to the growers. Hence, total savings of reduced water consumption in the Burdekin District would be in the order of $1.1 million annually.

There are also significant environmental and other non-costed benefits derived from the reduction in water usage. The potential for salt water incursion through excessive use of underground water in fringing areas of the Burdekin delta may be reduced while in some areas of the BRIA, a reduction in deep drainage losses may assist in reducing the incidence of groundwater rise and saline seepage.

CONCLUSION

The participatory action learning process has helped reinforce the usefulness of evaporation mini-pans for irrigation scheduling and enabled growers to better understand the responsiveness of the cane crop to soil moisture. By collecting water use data on their own farms, growers have become increasingly aware of the extent of the irrigation inefficiencies and are more willing to try cultural/management strategies to minimise the losses from the root zone. This process has provided the cooperators with ownership of the information. It has also improved the credibility of the results within the grower community and enhanced the transferability of the adjustment practices.

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