capacity of 878 m^2/h was obtained at 1.86 km/h speed for the 450 mm width blade at 20 mm depth of operation. A minimum effective field capacity of 364 m^2/h was obtained at 1.49 km/h forward speed for the 250 mm width blade at 60 mm depth of operation.

The test results reveal that there is scope to carry out the weeding operation in between the row crops with the help of the motor operated weeder.

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HYDRAULIC DESIGN AND PERFORMANCE EVALUATION OF A SEMI-AUTOMATED SURGE IRRIGATION DEVICE

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ABSTRACT

Extensive experimentation on surge flow furrow irrigation has confirmed its supremacy over the continuous flow irrigation as realised through quicker water front advances, reduced infiltration rates and high order of soil moisture storage and distribution efficiencies. To facilitate surge flow into furrows, two semi- automated surge irrigation device were fabricated and evaluated. These devices operate satisfactorily in effecting surge flow in the non-erosive and non-silting furrow discharge of 1.0 ls^{-1} and specific surge cycle ratios of 1/2 and 1/3 under low to medium operating pressure head of around 40 cm of water.

KEY WORDS : Surge flow, cycle ratio, surge device

In Tamil Nadu, the conventional furrow layout comprising short strip furrows (4 - 6 m long) carved on level basins are predominantly used for raising row crops, while rice is cultivated in basins. The short strip furrow layout leads to more than 20 per cent of the area lost for cultivation. Too many field inlets and manual cutting and plugging of cross ridges and feeder channels to divert water into furrows require more time and labour to complete irrigation. Besides, on account of extensive channel conveyance losses through seepage and deep percolation, the irrigation efficiencies in short strip furrow layout get reduced and the area lost results in lower plant populaiton. A long furrow (100-200 m long) layout coupled with surge irrigation seems to be a feasible solution in order to minimise the land loss and to maximise irrigation efficiencies.

Surge irrigation (Hymphereys, 1989) is a relatively new technique whereby water to surface irrigated furrows is applied intermittently in a series of relatively short ON and OFF time periods of irrigation cycles. The net result is a reduction in soil infiltration rates (Izuno *et al.*, 1985) and an increase in the rate of water front advance. Thus, the difference in intake opportunity time between the upper and lower ends of the furrow becomes less and results in a more uniform soil moisture storage and distribution along the furrow after irrigation (Bishop *et al.*, 1982 ; Elliot *et al.*, 1983).

MATERIALS AND METHODS

Semi-automated surge irrigation device

Figure 1 depicts the technical features of the two TNAU model semi-automated surge irrigation device (Senthilvel, 1994). The device comprised of 100 mm dia and 6 m long concentric pipes with 25 mm dia orifice holes spaced 60 cm apart to suit the normal furrow spacing of 60 cm for row crops. The outer pipe is stationary with collinear orifice openings and is fitted to an inlet tank intended for creating the desirable conditions of operating pressure heads for furrow in flows at specified rates. The rotatable inner pipe has holes of the same size and spacing but are in a zig-zag fashion to suit the opening of outer orifices upon coincidence at the design cycle ratios (1/2 or 1/3). The inner pipe is rotated with the help of a lever at the end of the pipe. Brackets and props are provided to avoid sagging of the pipe and to impart anchorage into the soil at the furrow head end. Laboratory calibration of the device was done for orifice discharge Vs operating pressure head of water for field use. At a cycle ratio of 1/2 i.e., $T_{off} = T_{on}$ the lever position enables discharge through a set of odd numbered orifices (1, 3, 5, 7 and 9) while the even numbered orifices (2, 4, 6, 8 and 10) are closed. By changing the lever position, after the design ON time, the even numbered orifices will discharge water while the odd numbered orifices assume an equal OFF time. At a cycle ratio of 1/3 i.e., $T_{off} = 2\ T_{on}$ the lever positioning enables sequential on time operations of the orifices numbered 1, 4, 7 and 10 as first set, 2, 5 and 8 as second set and 3, 6 and 9 as third set.

The surge timing for field evaluation of the unit were worked out as follows :

$$T_n = \frac{WLd}{600\ Q} \quad (1)$$

$$T_{ON} = T_n/N \quad (2)$$

$$T_{OFF} = \frac{(1 - R_c)}{R_c} . T_{ON} \quad (3)$$

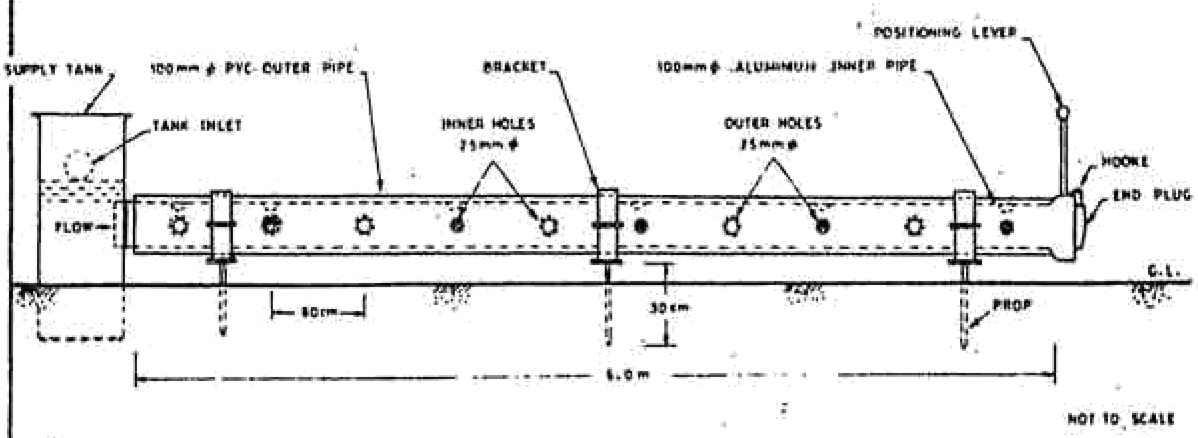

Fig. 1 . SEMI- AUTOMATED SURGE IRRIGATION DEVICE : FIELD INSTALLATION - [Rc = ½]
(TNAU MODEL)

$T_c = T_{ON} + T_{OFF}$ (4)

$T_g = N.\,T_c - T_{OFF}$ (5)

where,

W = Spacing of the furrows, cm

L = Length of the furrow, m

d = Depth of irrigation, cm

Q = Furrow discharge, ls^{-1}

T_{ON} = ON-time of the surge cycle, min

T_{OFF} = OFF-time of the surge cycle, min

T_c = Surge cycle time, min

T_n = Net duration of irrigation, min

T_g = Gross duration of irrigation, min

N = Number of Surge cycles

Rc = Cycle ratio

The furrow inflows were effected as per 1/2+1/3 surge cycle timings and observation were

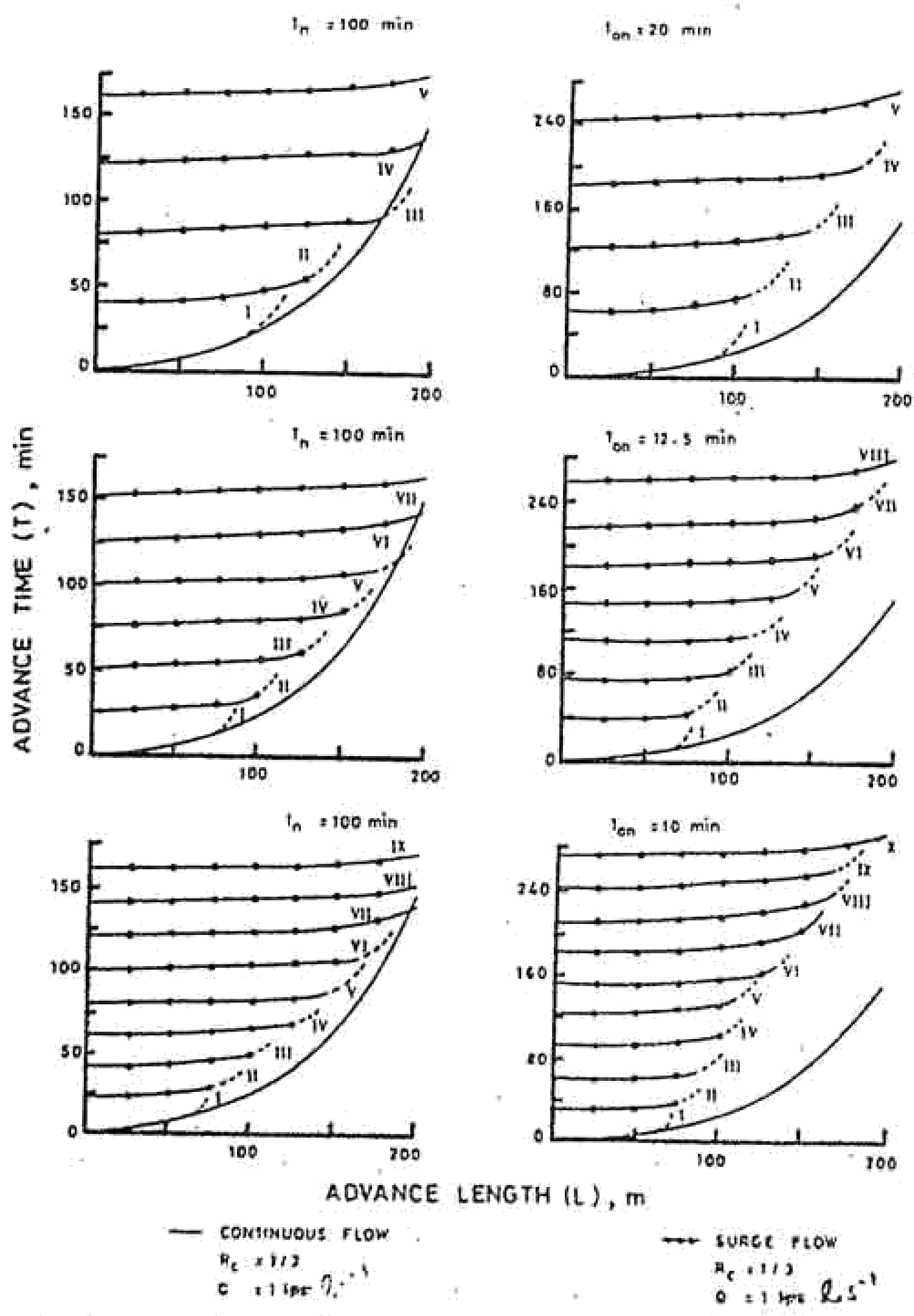

Fig. 2. Water front advance patterns in 60 cm single row furrows

made on the water front advance, infiltration (Inflow-outflow method) and soil moisture storage and distribution from head to tail end of the furrow (using Neutron Probe measurement). The irrigation efficiencies were then worked out.

RESULTS AND DISCUSSION

Effect of surge flow on water front advance

Figure 2 depicts the water front advance patterns under surge flow at the given cycle ratios and number of surge cycles to complete irrigation. The same under the continuous flow is superimposed for a comparative analysis.

A furrow inflow of 1.0 ls^{-1} at a cycle ratio of 1/2 made the advancing water front to reach the tail end of the furrow in an average net time of 81 min in the fourth surge of 5 cycles, 78 min in the sixth surge of 8 cycles and 76 min in the seventh surge of 10 cycles to complete 5 cm irrigation in a net duration of 100 min. For the same conditions of flow, surge flow at a cycle ratio of 1/3 caused the water front to reach the tail end in 120 min in the fifth surge of 5 cycles, 108 min in the eighth surge of 8 cycles and 105 min in the tenth surge of 10 cycles.

Effect of surge flow on infiltration rate

It is observed from Fig.3 that the basic infiltration rates are reached much quicker under surge flow compared to the continuous flow. While under the continuous flow, it took nearly 3 hours for the soil to reach its basic intake rate, under surge flow, the net time elapsed for the same was from 35 min for Rc = 1/3 and 25 min for Rc = 1/2 with the inflow discharge of 1.0 $1s^{-1}$. This drastic reduction in infiltration rates over shorter spells of time during irrigation results in quicker water front

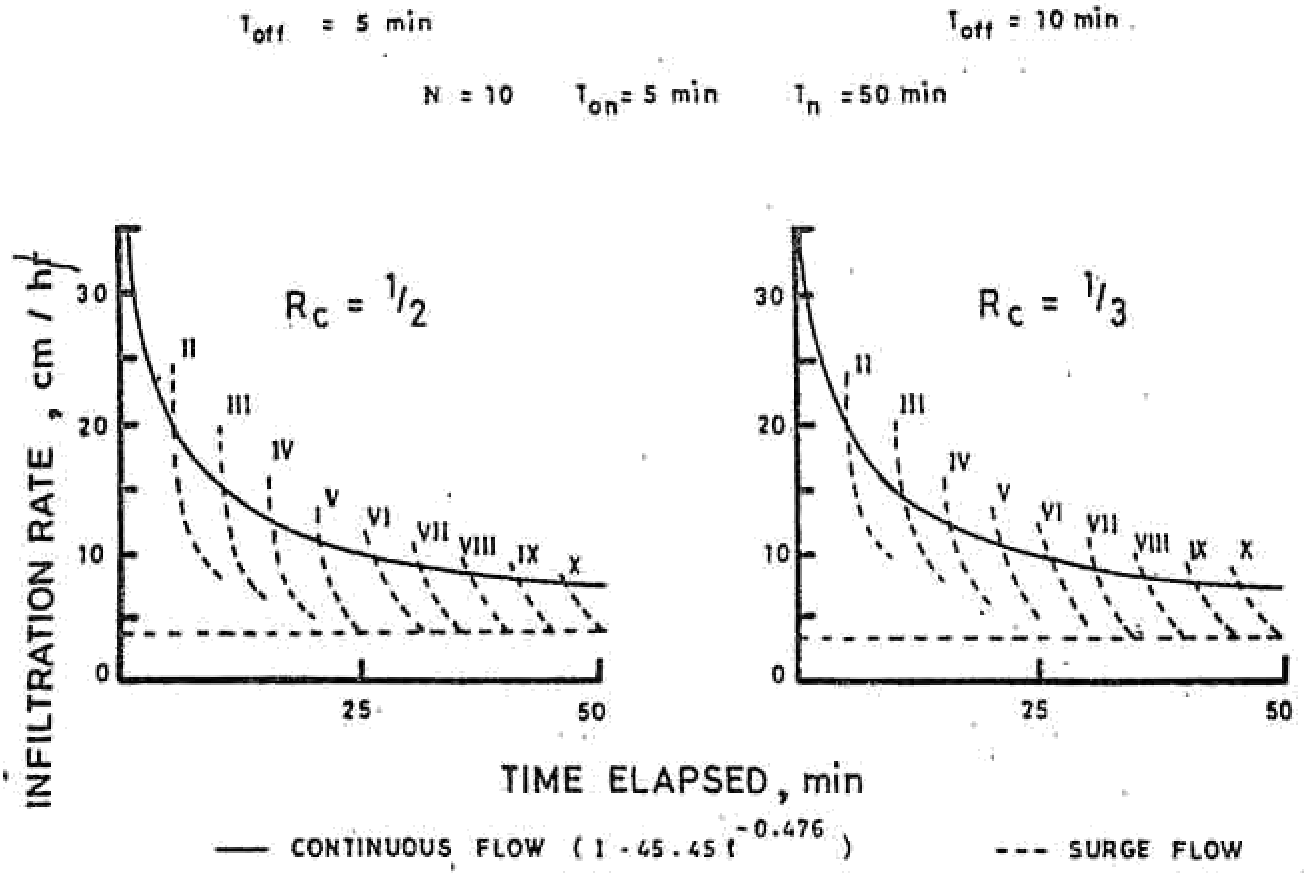

Fig. 3. Infiltration pattern under surge flow

advance, lesser deep percolation losses, better soil moisture storage and distribution compared to continuous flow.

Effect of surge flow on soil moisture storage and distribution

The irrigation efficiencies from the variations in soil moisture before and after irrigation for an effective root zone of 60 cm and keeping 120 cm as the depth for moisture analysis summarised that for a furrow length of 200 m, the continuous flow at 1.0 ls^{-1} has resulted in more deep percolation losses (1.36 cm) out of 5 cm depth of irrigation, with an irrigation distribution efficiency at 55%. In case of surge flow at a cycle ratio of 1/2, the deep percolation losses were reckoned as 0.90, 0.78 and 0.66 cm respectively for 5, 8 and 10 number of surges. The respective distribution efficiencies were worked out as 67, 73 and 80 which are high compared to the continuous flow. At a cycle ratio of 1/3 the deep percolation losses were observed as 1.10, 0.96 and 0.86 cm and the distribution efficiencies as 66, 72 and 75 respectively for 5, 8 and 10 surges.

From the discussion, it was established that surge irrigation has an edge over the continuous flow in respect of quicker water front advance, reduced infiltration rates and higher irrigation efficiencies.

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PERFORMANCE EVALUATION OF ROLLER GRADER FOR LIME

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ABSTRACT

A divergent type roller grader was developed and tested for size grading of lime. The unit is capable of grading 400 kg h^{-1} of fruits at 8% slope. The effectiveness of the grader is found as 85%.

KEY WORDS : Roller sorter, capacity and effectiveness

Lime or Nimbu (*Citrus aurantifolia*) is a native fruit of india. It is cultivated in many tropical countries. The fruits are small, round, smooth with yellow or greenish yellow skin and vary in size.

Grading of lime is done to improve its price during marketing. The most important grade factor for lime is size. Manual grading is a time consuming and labour intensive process. Screen and other types of graders were ineffective, slow and require more power in grading lime. Malcom and Garmo (1953) carried out extensive tests on fruits and potatoes using roller tables with the facility to alter translation speed, roller rotation speed and operating positions. Roller sorters were fast, accurate and cause little damage to fruits (Henderson and Perry, 1976). In the present study a divergent roller grader was developed, its capacity and effectiveness in grading lime was also tested.

MATERIALS AND METHODS

The roller grader comprised of a wooden stand, wooden frames, mild steel slotted iron pieces, rollers, feeding tray, rope and pulley, outlets etc.

The stand and frames were connected at top and bottom to ensure rigidity. The slotted iron