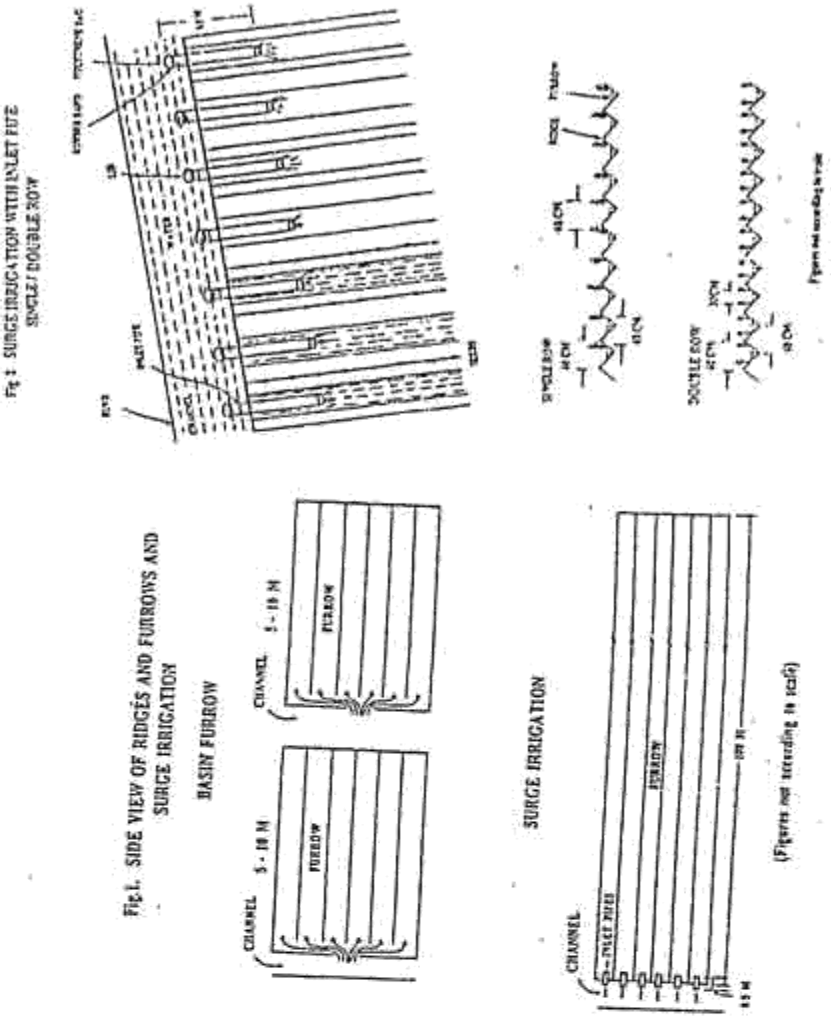

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Surge irrigation studies in maize (ii) water front advance in relation to geometry and T on – off timings

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Abstract : Water front advance in relation to crop geometry T on-off timing under continuous and surge flow was studied in Tamil Nadu Agricultural University. The soil was sandy clay loam. The slope was 0.5 per cent. Cost free surge layout was adopted using inlet pipes (50 x 7.5 cm) and manually operated. Water front advance took more time for continuous irrigation as compared to surge flow. Among the crop geometry, water front advance was faster under double row as compared to single row. Out of three T on-off timings there was not much difference in water front advance between 10 and 15 minutes. Water front advance was faster in 20 minutes. Surge irrigation in maize with single crop row geometry and T on-off timings of 10-15 with a flow rate 1.5 lps is optimum from the point of view of water front advance.
(Key words : Surge irrigation, Water front advance, Geometry)

Surge irrigation is the delivery of water into the furrow in an alternate fashion relatively over short span of interval so as to enable the particle displacement, deposition, reorientation and surface sealing to provide increased opportunity time for water front advance and to avoid excess infiltration

and surface runoff. Surge irrigation studies are new to India due to the very high cost for automated and semi-automated surge devices. Under Indian conditions there is the need for evolving low cost or cost free surge devices. This has been accomplished by laying out a head channel of 0.75 m width and furrows of required size according to the row spacing of the crop. Inlet pipe of 50 x 7.5 cm were placed on the start of head channel linking the furrows to enable the drawal of water with the designed rate of 1.5 lps per furrow. In surge irrigation the study of water front advance is a vital part. In an experiment laid out at Tamil Nadu Agricultural University with different planting geometry and T on-off timings the water front advances and recessions were studied in maize crop. In this study water front advance data are presented and data on recession is not presented.

Methods and Materials

Studies were taken up at Tamil Nadu Agricultural University, Coimbatore, situated in the North Western Agroclimatic zone of Tamil Nadu at 11° N latitude and 77° E longitude at an altitude of 427 m above mean sea level. The soil texture is sandy clay loam. Details on soil physico-chemical properties and soil moisture constants are given in the article entitled "Surge Irrigation Studies in Maize (I)". The maize cultivar was CO.1. Surge irrigation studies with three T on-off timings (on-off ratio=1) along with two crop geometry and two irrigation methods were involved. A farmers' control of basin furrow (10 x 9m) was also maintained. The furrow length was 150m. The flow rate was 1.5 lps and the irrigation was scheduled at the cumulative pan evaporation value of 66mm. The treatment details were as follow:

Single row continuous flow (T_1)

Single row surge flow T on–off 10 min. (T_2)

Single row surge flow T on–off 15 min. (T_3)

Single row surge flow T on–off 20 min. (T_4)

Double row continuous flow (T_5)

Double row surge flow T on–off 10 min. (T_6)

Double row surge flow T on–off 15 min. (T_7)

Double row surge flow T on–off 20 min. (T_8)

Farmers' method basin-furrow (T_9)

The experiment was laid out in Randomized Block design with two replications. Normal package of practices was adopted. Water front advance and water requirement were studied for different treatments.

Results and Discussion

Single row continuous flow (Fig.1)

This treatment took 140 min. to reach 150 m length in the first irrigation. In the first 10 min. water advanced 46 m and in 30 min. water advanced 79.5 m. To cover the balance distance of 70.5 m the time taken was 100 min. for the first irrigation. Life irrigation took 50 min. which was scheduled on the third day of first irrigation. Water advance was faster near the head and when the distance increased it progressively decreased.

Single row surge flow (T on–off 10 min.) (Fig.1)

Under this treatment, the first irrigation took only 60 minutes to reach the tail end of 150m length. More than 50 per cent of the total distance was covered in 20 minutes and the remaining distance took more time. For initial irrigation the distance of 150m length was covered in six surges and the number of surges reduced to 5 from 3rd irrigation upto 7th irrigation and later it increased again for surges.

Single row surge flow (T on–off 15 min.) (Fig.2)

In the single row treatment with T on–off 15 minutes first irrigation took 5 surges, from 5th irrigation onwards the number of surges to complete 150m length it took 3 surges upto 7th irrigation and increased to four for further irrigations. The advance was similar to the previous treatment but with increased distance for every surge.

Single row surge flow (T on–off 20 min.) (Fig.3)

In the single row surge flow of T on–off 20 minutes there were three surges for the water front advance to reach the total distance of 150 m length. It took only two surges after the fourth irrigation.

Double row continuous flow (Fig.4)

First irrigation under this treatment took 170 minutes for water front advance to reach the tail end of 150m. More than 50 per cent (77.5m) of the total distance was covered in 30 minutes. In the third irrigation 100 minutes was taken to complete the irrigation. Water front advance was faster initially and it reduced later.

Double row surge flow (T on–off 10 min.) (Fig.5)

Under this treatment the first irrigation took 80 minutes for accomplishing the advance to a length of 150m. It was only 47 per cent in terms of duration as compared to continuous flow. During the third and fourth irrigations only five surges were

needed. The advance was initially faster, followed by slow advance as distance progressed. The distance of coverage due to recession to start with lesser, increased in between and again reduced (data not furnished). The advance and recession distance covered for each surge was lesser than that of single row treatment with similar on-off timings.

Double row surge flow (T on-off 15 min.) (Fig.5)

This treatment took six surges accounting for 90 minutes for water front advance to a length of 150 m length. The life irrigation on the third day took only 25 minutes to complete the irrigation (data are not furnished). In the third irrigation number of surges reduced to five and in the fourth irrigation it was only four surges. There were only three surges for fifth and seventh irrigation. Again the number of surges increased to four in the eighth and ninth irrigations.

Double row surge flow (T on-off 20 min.) (Fig6)

In double row surge flow of 20 minutes there were four surges to reach the total distance of 20 minutes. Life irrigation on the third day took only 20 minutes for the water front advance to reach the tail end. Third irrigation took three surges. From fourth irrigation to ninth irrigation the number surges were two.

The advance of water under surge flow was faster than continuous flow and it was very clear that in the first irrigation hydraulic and infiltration characters were extreme. This result is in agreement with the findings of Bishop *et al.*, (1981) who experienced maximum surge effect during the first irrigation. The advance under surge flow re gistered approximately 43 to 53 per cent of time in single row geometry and 71 to 79 per cent time under the double row geometry, over the elapsed time of the continuous flow. There was saving of 21-36 per cent water under single row geometry and 25 to 28 per cent under double row geometry. The advance under surge irrigated furrow required only 28 per cent as much applied water as that required by continuous flow in furrow (Izuno *et al.*, 1985). The potential benefits using surge rather than continuous irrigation include faster advance, an increase in infiltration unidormity, a red= uction in total volume of water required for irrigation and reduced total irrigation time (Podmore et al, 1983).

The increased total time for completion of the initial irrigations under the single row geometry was more than as double row geometry. It is due to the resistance offered in the single row geometry as compared to double row geometry. Water utilized by single geometry was more than double row geometry. It is clear that continuous flow and farmers' method recorded higher water requirement over surge flow. Water saving was higher in surge flow treatments as compared to other methods. Between crop geometry, double row recorded early water front advance as compared to single row crop geometry. As a overall performance the time taken was higher in continuous flow > farmers method > surge flow. Among the three surge flow times T on–T off 10 minutes and 15 minutes water front advance was almost same. The advance is faster with T On–T OFF=20 minutes but not of much use. Surge flow time may be 10 to 15 minutes for a length of 150 meters with a flow rate of 1.5 lps. Though there was water economy under double row, single row geometry is preferable for better yield components and yield as seen from the data (given in the previous article). It is concluded for maize crop with a row spacing of 60 cm, single row geometry, T on–off timing of 10 or 15 with a flow rate of 1.5 lps is optimum for a length of 150m furrow length.

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Table 1. Single row geometry continuous flow T1

Surge No.	Time (min)	Advance (m) Irrigation Number			
		I	III	V	VIII
1	10	46	47.3	59.7	58.7
2	20	65.3	75.3	93.4	94.1
3	30	79.5	97.6	118	117.9
4	40	91.6	116.3	130.5	129.3
5	50	98.0	128.7	143.2	144.0
6	60	105	137.8	150	150
7	70	110.4	147.6		
8	80	115.0	150		
9	90	118.7			
10	100	125			
11	110	127.4			
12	120	130			
13	130	142			
14	140	150			

Table 2. Single row geometry surge flow (T_{ON}=T_{OFF}=10) T2

Single row geometry surge flow (T_{ON}=T_{OFF}=15) T3

Surge No.	Time (min)	Advance (m) Irrigation Number							
		I	III	V	VIII	I	III	V	VIII
1	10	46	48.5	53.0	48.0	58.5	71.5	82.7	82.5
2	20	76.5	77.8	91.6	78.7	92.5	102	120.3	112.7
3	30	97	99.0	118	101.6	116.4	120	145.3	127.8
4	40	115.2	116.0	128	120.7	129	128.8		146.1
5	50	132	129.4	145.1	132.1	141	143		
6	60	145	143	142.0					

Table -3. Single row geometry surge flow (T_{ON}=T_{OFF}=20) T4

Surge No.	Time (min)	Advance (m) Irrigation Number			
		I	III	V	VIII
1	10	72.5	86	96.2	97.1
2	20	121.5	125.5	135.7	134.0
3	30	150	145		

Table 4. Double row geometry continuous flow T5

Surge No.	Time (min)	Advance (m)			
		Irrigation Number			
		I	III	V	VIII
1	10	40	38.80	42.5	43 0
2	20	58	66.30	70.80	73.5
3	30	77.5	84.15	100.50	101.5
4	40	90.8	97.90	120.50	120.1
5	50	100	109.40	135.20	138.2
6	60	107.6	120.50	145.90	146.7
7	70	117.10	127.00	150.00	150
8	80	121.30	133.20		
9	90	130.00	141.60		
10	100	133.00	150.00		
11	110	135.20			
12	120	136.80			
13	130	139.00			
14	140	143.00			
15	150	145.00			
16	160	147.00			
17	170	150.00			

Table 5. Double row geometry surge flow (T_{ON}=T_{OFF}=10) T6

Double row geometry surge flow (T_{ON}=T_{OFF}=15) T7

Surge No.	Time (min)	Advance (m) Irrigation Number							
		I	III	V	VIII	I	III	V	VIII
1	10	36.0	37.3	50.0	49.0	40.4	51.3	90.8	80.1
2	20	71.5	75.0	82.0	80.0	66	82.3	120.5	105.7
3	30	86.1	96.3	107.4	106.4	90	106	140	130.1
4	40	100.4	125.3	126.4	124.3	110.5	129.2		145.3
5	50	115.1	130.0	142.4	140.0	135	142		
6	60	126.1	144.6			147			
7	80	134							
8	80	143							

Table 6. Double row geometry surge flow (T_{ON}=T_{OFF}=20 min)

		Advance (m)			
		Irrigation Number			
Surge No.	Time (min.)	I	III	V	VIII
1	10	66.5	75.5	96.8	99
2	20	97.0	97.4	134.4	137.5
3	30	125.2	128.4		
4	40	150	150		

Figure 1. Water front advane in geometry, method of irrigation and on–off timing surge (T_{ON}=T_{OFF}=10 MIN) and continuous flow - single row

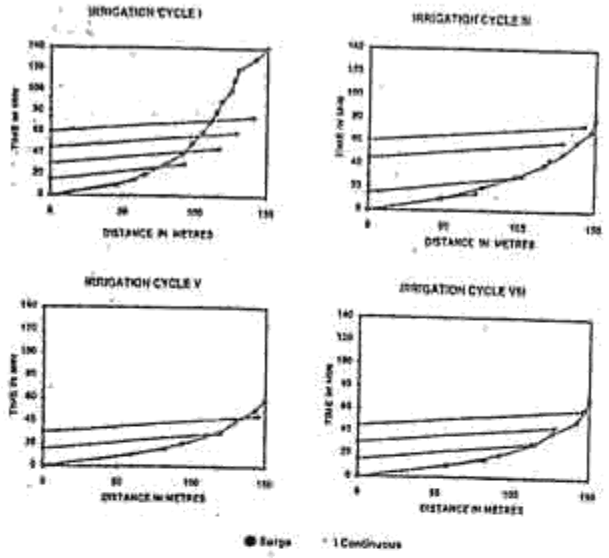

Figure 1. Water front advane in geometry, method of irrigation and on–off timing surge (T_{ON}=T_{OFF}=10 MIN) and continuous flow - double row

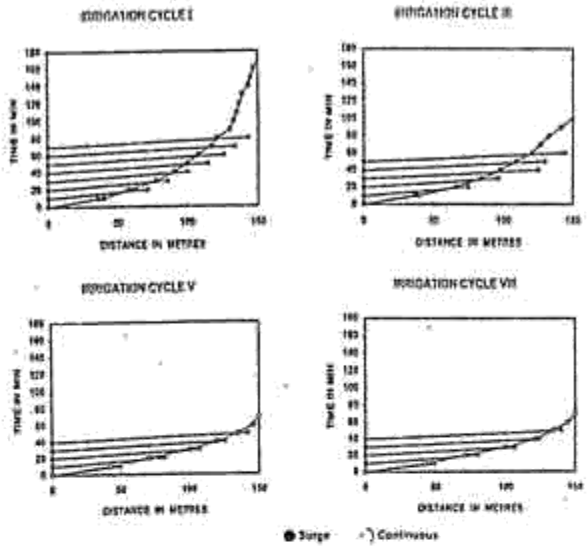

Figure 2. Water front advane in geometry, method of irrigation and on–off timing surge (T_{ON}=T_{OFF}=15 MIN) and continuous flow - single row

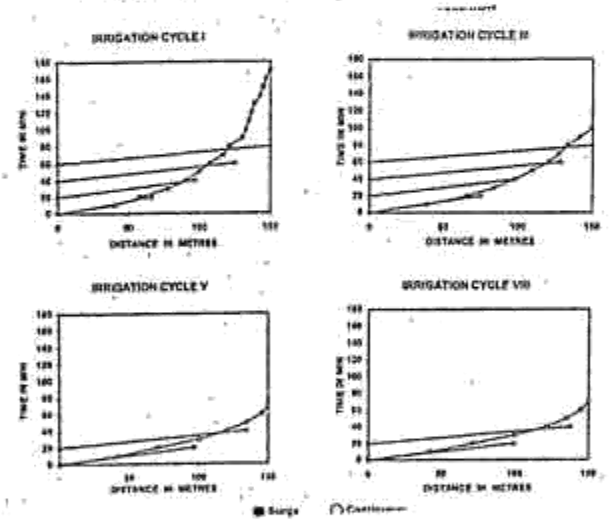

Figure 2.Water front advane in geometry, method of irrigation and on–off timing surge (T_{ON}=T_{OFF}=15 MIN) and continuous flow - double row

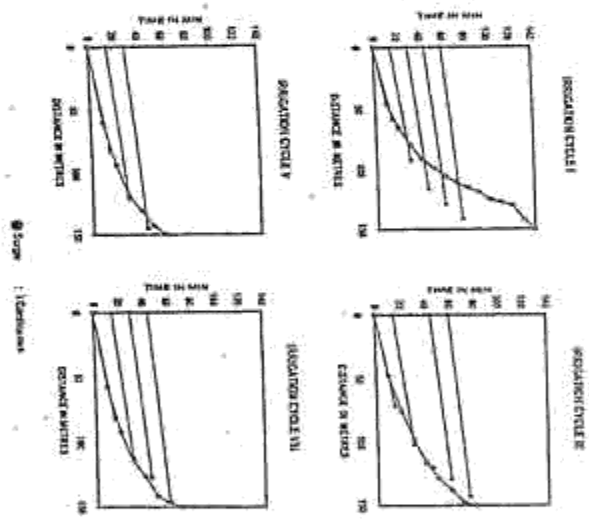

Figure 3. Water front advane in geometry, method of irrigation and on–off timing surge (T_{ON}=T_{OFF}= 20 MIN) and continuous flow - single row

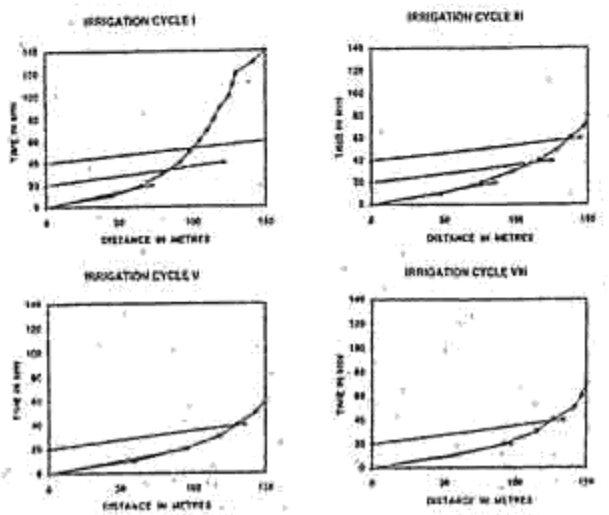

Figure 3. Water front advane in geometry, method of irrigation and on–off timing surge (T_{ON}=T_{OFF}= 20 MIN) and continuous flow - double row