3. Method of Furrow Irrigation (1976)

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Furrow irrigation on the flat land is usually made by impounding water on soil surface. In order to maximize the efficiency of irrigation water, it is important to estimate the optimum values of flow rate and furrow length from the view point of irrigation engineering. Such items can be evaluated by analizing the results from irrigation tests on the field, preferably under the condition planted to crops.

Accordingly the flow tests were carried out in the dry season of early 1976 under the following methods:

1. Material and method:
   1) Flow rate treatment

Plot Sign	Siphon used for flow rate control
A	ϕ 34 mm siphon for each furrow
B	ϕ 41 mm siphon for each furrow
C	Coupled ϕ 41 mm siphon for each furrow
D	Coupled ϕ 41 mm siphon for every other furrow
E	ϕ 41 mm siphon for every other furrow

   2) Planted condition
      Crop: Mungbean (SPR No.1)
      Seeding: March 5
      Spacing: 0.75 m × 0.2 m
      Plot area: 80 m × 5 rows × 0.75 m = 300 m^2
   3) Irrigation
      Four times on March 9, 22, 29 and April 5.
2. Result:
   The following facts were found by examining the experimental results with reference to the adaptability of furrow irrigation on flat field of heavy clayey soil.
   1) The depth of water which will be replaced by each irrigation is about 20 mm. Such small values are due to the moisture in sub-layers which is hardly consumed during the growth stage under the test. Consumptive use is about 3.0 mm/day which corresponds to less than half the value of pan evaporation.
   2) The advance rate of flowing water in the furrow is expressed as $\tau=\alpha L\beta$ (where, τ=elapsing time (minute); L=length of furrow; α=constant; β=exponent). The exponent shows relatively large values as compared with upland. In other words, it means smaller advance rate than in upland. Such trend is due to the large amount of water ponded on the furrow. Soil erosion is not observed even in C plot where the largest flow rate has been given. Overtopping of water might be a critical factor for determining a maximum allowable flow rate rather than the erosibility of soil under such flat field. From this point of view, it is considered that the flow rate of 1.0 to 1.51/sec is almost maximum.
   3) An integral equation has been used for estimating the intake rate of soil. Inflow

and outflow method used generally, is not adaptable due to the large amount of side seepage eventhough buffer furrows has been prepared at the both sides of the test furrow. Since water hardly permiates to sublayer, the values of furrow intake rate are small. Basic intake rate is less than 2.0 mm/hr.

4) The loss of irrigation water in the field has been calculated by using these results. It is evident that furrow irrigation is easily applicable to the field of heavy clayey soil. The maximum allowable length of furrow is about 160 — 220 m. 'Two flow irrigation method', which consists of a large flow rate kept until the front of flow reaches the midway of a furrow and a small flow rate kept thereafter, is recommendable for high water efficiency.

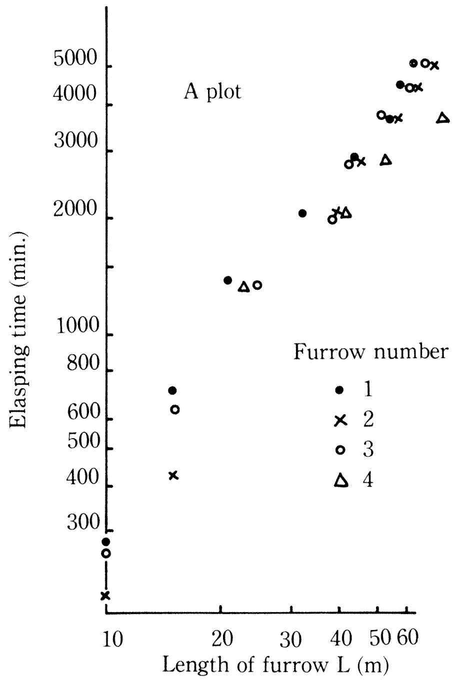

Fig. 3-1. Rate of advance (1st irrigation)

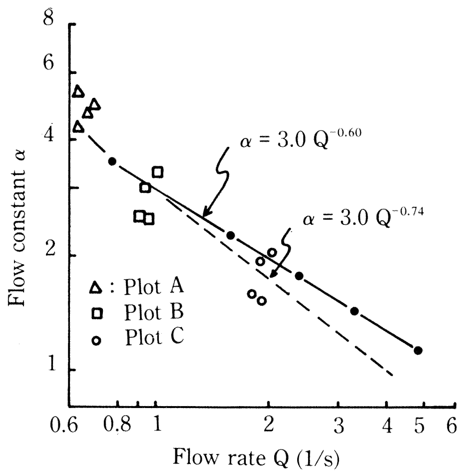

Fig. 3-2. Flow constant

Table 3-1. Intake constants

plot sign	N_R	V_0 (m/s)	K (mm/hr)	n	C (mm)	i_B (mm/hr)
A	1	0.301	49.1	0.578	1.9	1.6
	2	0.305	44.1	0.582	1.8	1.7
	3	0.349	34.2	0.564	1.3	1.3
	4	0.352	32.1	0.510	1.1	1.8
C	1	0.595	86.7	0.667	4.3	1.6
	2	0.744	62.3	0.604	2.6	1.7
	3	0.708	57.6	0.592	2.4	1.9
	4	0.686	66.1	0.558	2.5	2.5

Remarks: $C = \frac{K}{60\,(n+1)}$

N_R: repeat number of irrigation-

Table 3-2. Loss ratio (two flow method)

Q (l/s)	L (m)	τ_0 (min)	$\tau\frac{1}{2}$ (min)	I_1 mm	t_2 (min)	I_2 (mm)	I (mm)	t (min)	I_{min} (mm)	L_R (%)
	40	44	15	9.0	53	21.0	30	67.5	29.4	2.0
	80	124	44	13.2	84	16.8	30	128	28.4	5.6
0.3	120	255	84	16.8	99	13.2	30	183	26.8	11.9
	160	405	134	20.1	99	9.9	30	233	24.8	21.0
	200	580	190	22.8	90	7.2	30	280	22.7	32.2
	40	28	9	10.8	48	19.2	30	57	29.7	1.0
	80	83	28	16.8	66	13.2	30	94	28.9	3.8
0.6	120	160	53	21.2	66	8.8	30	119	27.3	9.9
	160	252	83	24.9	51	5.1	30	134	26.8	11.9
	200	360	120	28.8	15	1.2	30	135	25.4	18.1
	40	19	6	12.0	45	18.0	30	51	29.8	0.7
	80	55	19	19.0	55	11.0	30	74	29.2	2.7
1.0	120	105	35	23.3	50	6.7	30	85	28.7	4.5
	160	165	55	27.5	25	2.5	30	80	28.0	7.1
	200	240	80	32.0	(20)	(1.6)	(31.6)	100	27.5	9.1
	40	11	3.6	14.4	39	15.6	30	43	29.9	0.3
	80	33	11	22.0	40	8.0	30	51	29.5	1.7
2.0	120	63	21	28.0	15	2.0	30	36	29.2	2.7
	160	99	33	33.0	(20)	(2.0)	(35.0)	53	28.8	4.2
	200	143	47	37.5	(20)	(1.6)	(39.1)	67	28.2	6.4

Q : First flow rate
τ_0, $\tau\frac{1}{2}$: Elapsing time needed to arrive at the length of furrow L, L/2
I_1, I_2, I : depth or intake of water
I_{min} : depth of water at the lower end of furrow
t, t_2 : irrigation time needed to refill I_1, I_2
L_R : Loss ratio

Table 3-3. Loss ratio (one flow method)

Q (l/s)	L (m)	τ_0 (min)	I (mm)	t (min)	I_{min} (mm)	L_R (%)
	40	44	17	39	15.7	8.3
	80	124	25	85	22.8	9.6
0.3	120	255	32	163	29.1	10.0
	160	405	38	255	34.3	10.8
	200	580	44	365	39.8	10.6
	40	28	21	17.5	20.4	2.9
	80	83	31	52	30.0	3.3
0.6	120	160	40	100	38.7	3.4
	160	252	48	160	46.2	3.9
	200	360	55	225	53.4	3.4
	40	19	23	11.5	22.6	1.8
	80	55	35	35	34.5	1.4
1.0	120	105	38	67	37.2	2.2
	160	165	53	104	51.6	1.7
	200	240	60	151	58.8	2.0
	40	11	28	7	27.7	1.1
	80	33	42	21	41.8	0.5
2.0	120	63	53	40	52.6	0.8
	160	99	63	63	62.6	0.6
	200	143	72	90	71.3	1.0