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FIELD STUDY ON CABLEGATION IRRIGATION SYSTEM

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ABSTRACT

A field study on Cablegation Irrigation System was carried out at the TamilNadu Agricultural University campus to examine the soil moisture storage and uniformity of moisture distribution. The system's performance was tested varying the pipe gradients to 1.0, 1.5, and 2.0 per cent and the outlet orientations to 60° and 90°. The system showed uniform depth of moisture storage along the lenght and depth of the Cablegation furrows whereas, the depth of storage decreased linearly from upstream to downstream end in the continuously irrigated furrow. The Uniformity Coefficient was found to be about 95 per cent, 20 per cent higher than that of the continuous. The overall performance of the system at both 60° and 90° orientations were good, only with slight variations in their moisture storage pattern at different pipe gradients.

KEY WORDS : Cablegation Irrigation System, Field study

Surface irrigation in our country has withstood the test of time because of its many advantages. However, their efficiency lies only around 55 per cent. Minor changes have been made to improve the efficiency of surface irrigation, but still the target of improving the efficiency above 55 per cent has not yet been reached. Realising this, an attempt was made to provide such an irrigation system that would not only lead to higher application and distribution efficiencies but also result in reduced labour requirements and low initial and maintenance costs. Cablegation is a new irrigation system that is being attempted in this direction. Cablegation refers to an automated mode of supplying water through a gated pipe system into the furrows. The pipe needs to be laid on a precise grade, causing water to flow through the outlets by moving a cable-attached plug slowly through the pipe (Kemper *et al.*, 1981).

An inherent characteristic of the system is that the flow to each furrow begins at a maximum rate and gradually decreases with time to zero. This gradual cut-back inflow rate has an effect on the furrow advance rates and infiltration distribution unlike other systems (Kincaid and Kemper, 1984).

METERIALS AND METHODS

The Semi-automated cablegation system developed was installed in the field to carryout the field study. The clay loam type soil had a basic infiltration of 1.32 cm/h with the field capacity and wilting point of 33.26 per cent and 14.06 per cent respectively. The bulk density was 1.24 g/cc.

The system designed consists of an inlet tank connected with 10 cm diameter PVC pipe (Fig.1). Outlets at 60 cm spacing were drilled to irrigate the furrows suitably. The water flow was controlled by

Table 1. Uniformity coefficient (1) Q=3.01ps; θ_1=60 degrees; S_1=1.0%

Parameters	Treatments cablegation furrows					Continuous
	1	3	5	7	9	
m	4.2700	3.856	4.211	4.025	3.3375	3.3575
n	4	4	4	4	4	4
x	1.34	0.455	1.028	1.140	0.4755	3.71
$C_u=100\,[1-\Sigma x/mn]$	92.15	97.10	93.90	92.90	96.44	72.40
	(2) Q=3.01ps; θ_2=60 degrees; S_2=1.5%					
m	3.6575	3.588	4.335	4.213	3.55	3.3575
n	4	4	4	4	4	4
x	0.885	0.810	1.300	0.950	0.20	3.71
C_u	93.95	94.40	92.50	94.40	98.60	72.40
	(3) Q=3.01ps; θ_2=60 degrees; S_3=2.0%					
m	4.03	3.733	4.429	4.313	3.473	3.3575
n	4	4	4	4	4	4
x	0.84	0.190	0.905	0.790	0.330	3.71
C_u	94.80	98.73	94.89	95.42	97.62	72.40

a cable attached leak proof plug, the movement of the plug being achieved with a hand operated reel attached to the inlet tank. A controlled manual plug speed of 2.4 m/min was arrived after conducting repeated plug movements with field staff.

Totally, nine cablegation furrows were formed of 35m length and 20cm deep at a spacing of 60cm to suit the outlets in the pipe with a separate furrow of same size as control. The depth of irrigation water given at 60 per cent soil moisture depletion was 5cm. The actual depth of penetration at this level was found to be 35cm by theoretical calculations. A controlled total inflow of 3 l/sec was fed into the inlet structure of the system to supply the selected number of furrows. Therefore the net duration of irrigation to cover all the 9 furrows was found to be 52.5 min. This duration was completed over certain number of cablegation

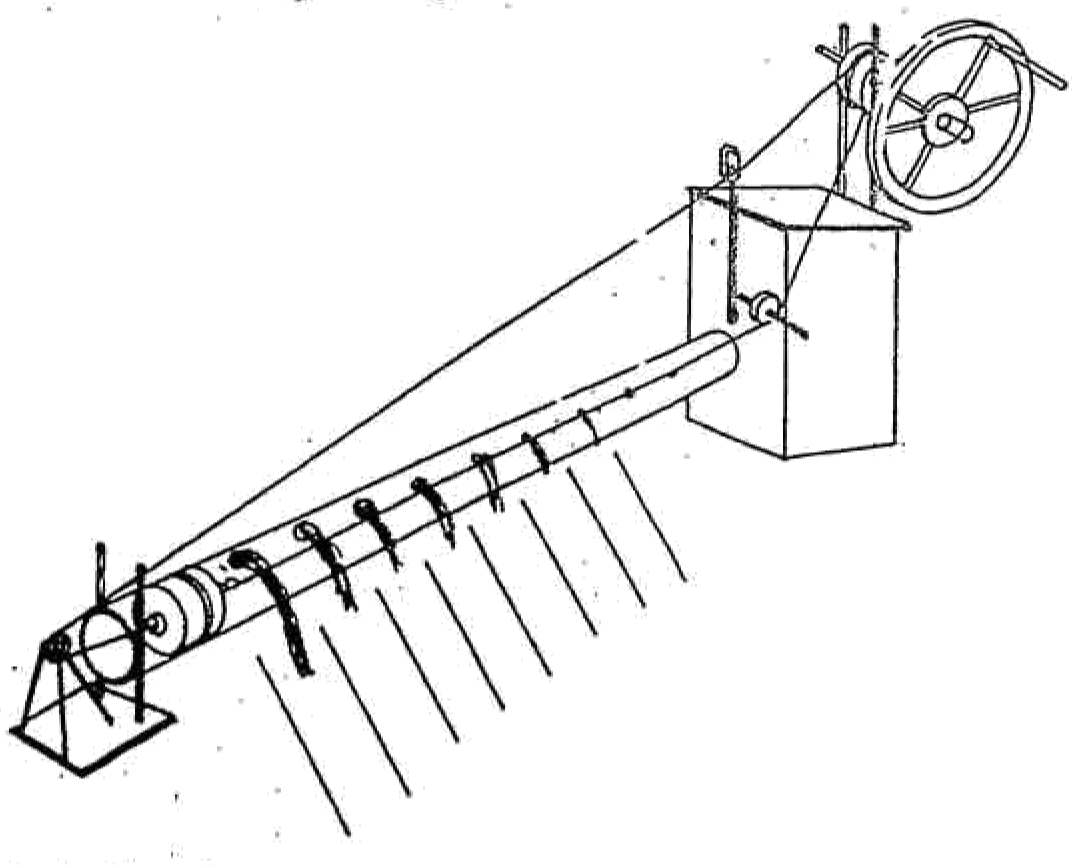

Fig.1 Cablegation- Flow pattern

Table 2. Uniformity coefficient (1) Q=3.01ps; θ_1=90 degrees; S_1=1.0%

Parameters	Treatments cablegation furrows					Continuous
	1	3	5	7	9	
m	3.591	3.810	4.145	3.958	3.095	3.3575
n	4	4	4	4	4	4
x	0.404	1.340	0.700	0.775	0.350	3.71
C_u	97.20	91.20	95.78	95.10	97.20	72.40
	(2) Q=3.01ps; θ_2=90 degrees; S_2=1.5%					
m	3.115	3.498	3.838	3.410	3.118	3.575
n	4	4	4	4	4	4
x	0.200	2.070	0.795	0.860	0.170	3.71
C_u	98.40	85.20	94.82	93.70	98.64	72.40
	(3) Q=3.01ps; θ_2=90 degrees; S_3=2.0%					
m	3.315	3.065	3.515	3.138	3.103	3.3575
n	4	4	4	4	4	4
x	0.350	0.220	1.240	0.465	0.170	3.71
C_u	97.36	98.21	91.20	96.29	98.63	72.40

cycles. Each cycle comprises the sum of the times taken by the plug to finish a complete 'to and fro' movement, with reference to the inlet point. The time required for a single cycle was found out and hence, the number of cycles required to complete 52.5 min of irrigation time was found out as 10.5. With an assumption that the water supplied through a level gated pipe system irrigates the continous furrows, each furrow receives an inflow of 0.3331ps. Therefore, the time required to supply this inflow was found to be 52.5 min for a single continuous furrow.

The alternative furrows were planted with the neutron probe access tubes at 0 m (head end) 5m, 17.5m and 30m from the furrow head end. A calibrated soil moisture probe was used to register the soil moisture storage before and after each irrigation at three selected depths of 0.15m, 0.30m

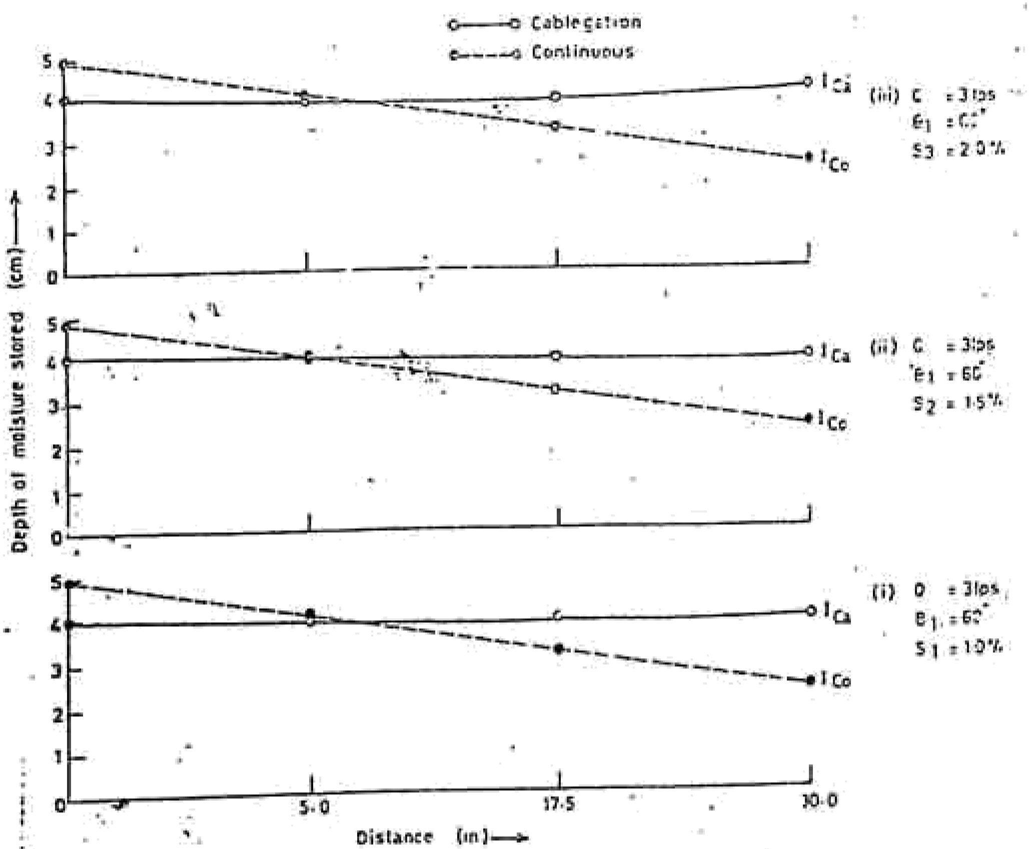

Fig.2 Average depth of moisture stored in Cablegation furrows in cm experiment - 1

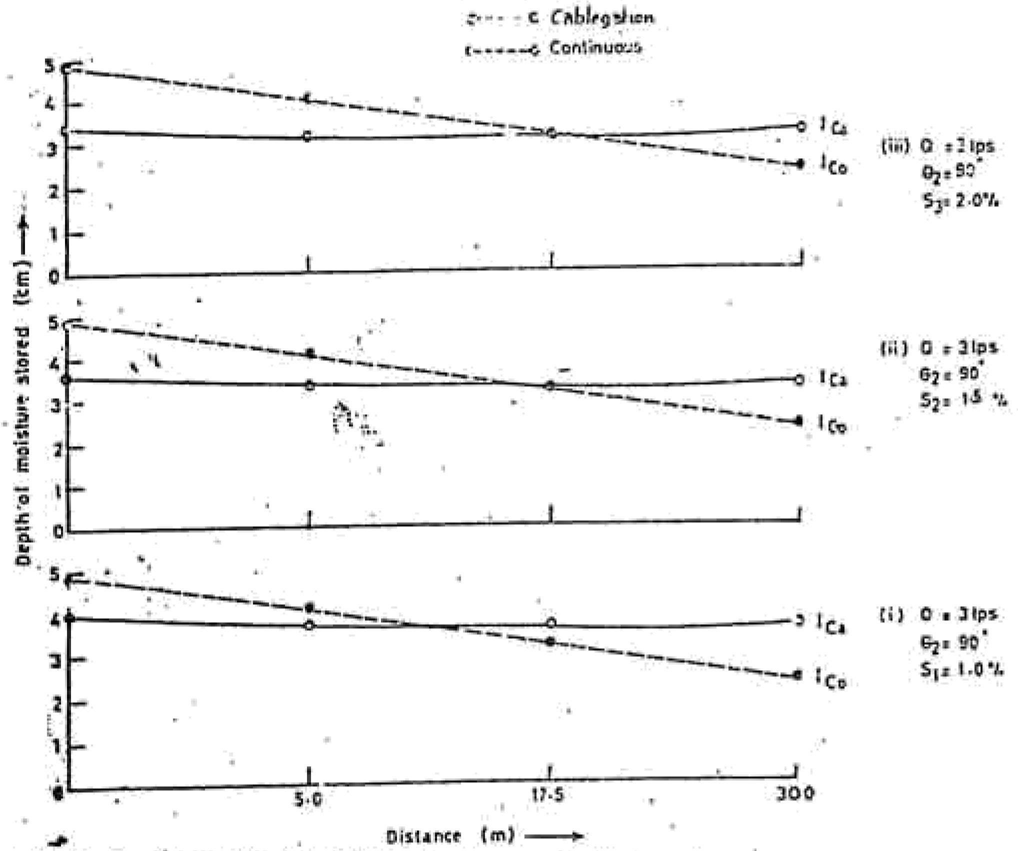

Fig.3 Average depth of moisture stored in Cablegation furrows in CM experiment - 2

and 0.35m from the soil surface. Using the moisture readings, the equivalent depth of water stored in the zone of 0 to 35 cm was found out using the formula $d = P \times A_s \times D/100$ in which,

d = depth of moisture stored, cm

p = moisture content stored, %

A_s = apparent specific gravity, dimensionless

D = depth of penetration, 35cm

The uniformity of moisture distribution was calculated using Christiansen's Formula :

$C_u = 100 \times (1.0 - x/mn)$

C_u = Uniformity coefficient

n = total number of observation points

m = mean value of all observations

x = deviation of individual observations from the mean value

RESULTS AND DISCUSSION

The system's efficacy on soil moisture storage and uniformity distribution were examined at pipe gradients of 1.0, 1.5 and 2.0 per cent with outlet orientations of 60° and 90°.

The calculated average depth of moisture in cm in the cablegation furrows and in the control at distances of 0.0m (head end) 5m, 17.5m and 30m from the furrow head end and are graphically represented (Fig. 2,3)

From the graphs, the following are summarised:

In cablegation furrows, the distribution of moisture was found to be uniform along the furrow length whereas there was linear decrease in the depth of moisture stored from upstream to downstream end of the continously irrigated furrow. The system resulted in uniform storage of moisture along the length of the furrows at both 60 and 90 degree orientations. Only those furrows on the upstream and downstream sides indicated variations in their moisture storage because of insufficient discharge on those furrows. However, the uniformity was found to be good.

The system showed only slight variations in the depth of moisture stored at different pipe gradients.

The uniformity coefficient calculated are given in the Tables 1 and 2. On comparison with the conventional method, the cablegation furrows at both 60° and 90° orientations resulted in fairly well distributed moisture pattern. The uniformity was found to be 20 per cent higher than that of the continuous.

The system's capability to creage "surge" effect caused the moisture storage to be uniform throughout as a result, higher efficiency.

The semi-automated cablegation system designed was only to suit 9 furrows. The overall performance was good comparing to the continuously irrigated furrows.

The variations in discharge in the outlets on the upstream and downstream sides can easily be rectified by modifying the outlet size or by positioning the plug near those outlets till they discharge the required quantities. This would provide still more uniform moisture storage efficiency.

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MODIFICATION AND TESTING OF A POWER-TILLER ROTOVATOR FOR FLAIL MOWING

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ABSTRACT

A power tiller operated rotovator was modified as a flail mower. The speed of rotovator shaft was increased from 255 to 1137 rev/min and the rotary blades were replaced with 6 mm size and 25 mm pitch mild steel chains of 280 mm length having a flat cutting element at the tip. The modified machine was evaluated for lawn mowing and parthenium cutting operations. The cost of conversion was Rs.1060/-. Maximum cutting efficiency of 97 per cent was achieved at 1100 rev/min rotor speed and 1.60 km/h forward speed. Average effective field capacity of the machine was 0.05 ha/h with average field efficiency of 56.3 per cent.

KEY WORDS : Power Tiller, Rotovator, Flailmower, Lawn Mowing, *Parthenium* Cutting

Mild steel chains of different sizes can be used as flails with a peripheral velocity of 2000 m/min for impact cutting of grass, *Desmostachya bipinnata* (Agarwal, 1976). A power tiller operated flail mower having 650 mm width of cut is capable of mowing one ha of grass in 16 h at 1 km/h forward speed with 97.4 to 98.0 percentage of cut (Ghatey, 1977). The flail type mower using chains as flails gives better cutting of plants with less noise and vibrations after attaching knives at the end of chains (Tajuddin, 1980; Tajuddin and Datta, 1983). Flail type mowers have more scope for cutting grasses due to their lower maintenance requirements, greater speed of operation and less damage caused to the cutting elements when used in stoney, stumpy and uneven fields (Tajuddin and Datta, 1984). Hence, a power tiller operated rotovator was modified as a flail mower having mild steel chains with cutting elements at the tip as flails.

METERIALS AND METHODS

Maximum clearance between the rotatovator (Mitshubishi make) cover and the rotovator shaft was 300 mm. Therefore, the length of 6 mm size and 25 mm pitch mild steel chain inculding the horizontal circular cutting element was adopted as 280 mm. The rotary blades were removed and the chains were connected in the place of blades. For obtaining 2000 m/min eri heral velocit with 560