TR-30

STUDY ON SOIL MOISTURE MOVEMENT DURING RAINFALL BY GREEN AND AMPT EQUATION AND COMPARISON OF THE STUDY BY NUMERICAL MODEL

SATISH CHANDRA
DIRECTOR

STUDY GROUP

RAMA DEVI MEHTA

NATIONAL INSTITUTE OF HYDROLOGY
JAL VIGYAN BHAVAN
ROORKEE-247667 (UP)

INDIA

1988-89

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SUMMARY

Soil moisture movement during a rainfall event has been studied using Green and Ampt approximate solution of infiltration. The soil moisture movement has also been predicted by solving Richard's equation. The solution obtained by Green and Ampt approximate solution has been compared with the numerical solution of Richard's equation.

Green and Ampt assume that water moves like a piston. Thus the soil behind the moving front is assumed to be completely saturated and the soil infront of the front is at the uniform initial soil moisture. This assumption leads to the fact that velocity of water at a particular time is invariant with depth.

In reality the soil moisture distribution with depth will be gradual. The velocity of soil water at different depth have been obtained using the numerical solution and compared with that corresponding to Green and Ampt equation.

Numerical solution is used to study the soil moisture movement taking into consideration the presence of capillary zone above the water table. The positions of saturation front at a particular time computed by both the methods have been compared.

1.0 INTRODUCTION

Groundwater recharge by rainfall and evapotranspiration from the uppermost soil layer occur while the overlying soil is in an unsaturated condition. So the flow of water in unsaturated soil has become one of the most important and active topics of research in hydrology and irrigation engineering. This research has resulted in significant theoretical and practical advances. The variable amount of water contained in a unit mass or volume of soil, and the energy state of water in the soil are important factor which affect the unsaturated flow.

In this study, a model has been developed to simulate the soil moisture profile in an initially unsaturated soil during infiltration. A software has been developed in Fortran IV langauge for simulating soil moisture profile. This model can be utilized for estimating total deep percolation losses and also for knowing the soil moisture distribution for different soil during rainfall or application of irrigation water. Green and Ampt infiltration equation has been used by several investigator for study of soil moisture movement. The infiltration rates predicted by numerical method and by Green & Ampt equation have been compared in the present study. Also, the velocity at different depths predicted by numerical method have been compared with the velocity predicted by Green & Ampt equation.

2.0 REVIEW

The formulation and solution of flow problems in unsaturated soil very often require the use of indirect methods of analysis, based on approximations or numerical technique. Darcy's Law, through originally conceived for saturated flow only, was extended by Richards (1931) to unsaturated flow, with the provision that the conductivity is a function of the matric suction head [i.e. $K = K(\Psi)$]

$$q = -K(\Psi)\,\nabla H \qquad 2.0.1$$

where ∇H is the hydraulic head qradient, which includes both suction & gravitational components. Childs (1950) have introduced the word diffusivity 'D'

where

$$D(\theta) = \frac{K(\theta)}{C(\theta)} = K(\theta)\,\frac{d\Psi}{d\theta} \qquad 2.0.2$$

D is thus defined as the ratio of the hydraulic conductivity K to the specific water capacity 'C'. Then Hillel (1982) employed the term hydraulic diffusivity to avoid the confusion between the classical concept of diffusivity pertaining to the diffusive transfer of components in the gaseous and liquid phases.

Gardner and Mayhugh (1958) have been given the relationship of hydraulic diffusivity to wetness by the empirical equation

$$D(\theta) = ae^{b\theta} \qquad 2.0.3$$

2.1 Problems Related to Soil Water Dynamics

Feddes et al (1978), Hayhoe & Dejong (1982) and Idike et al (1982) have developed numerical models for predicting soil water content at various depth.

Feddes et al have solved the differential equation

$$\frac{\partial \theta}{\partial t} = - \frac{\partial q}{\partial t} - S \qquad 2.1.1$$

for appropriate initial & boundary conditions,

in which, θ is moisture content of the soil, q is the volumetric flux and S represents the volume of water taken up by the roots per unit bulk volume of the soil in unit time.

According to Feddes et al the following initial condition is required to be satisfied while solving the unsaturated flow problem.

The pressure head is specified as a function of the depth Z at t = 0, i.e.

$$\Psi(z,t = 0) = \Psi_o \qquad 2.1.2$$

If hysteresis is not considered , this condition is equivalent to

$$\theta(z,t = 0) = \theta_o \qquad 2.1.3$$

and the value of Ψ can be obtained by an expression

$$\Psi = f(\theta) \qquad 2.1.4$$

Many problems related to infiltration of water into soil have been done by various researchers [Bouwer (1964, 1978), Bruce & Whisler (1973), Jensen (1973), and Hillel & Gardner (1970), and Jain & Murty (1985)].

According to Feddes et al the boundary conditions to be satisfied will conform to one of the following types:

(a) Dirichlet Type

Specification of the dependent variable, pressure head, at the boundary falls into this category and the boundary conditions are

$$\Psi(z = 0,t) = \Psi^{u}$$

$$\Psi(z = L,t) = \Psi^{L}$$

These conditions are equivalent to

$$\theta(z = 0,t) = \theta^{u} \quad \& \quad \theta(z = L,t) = \theta^{L}$$

(b) Neuman Type

Specification of the derivative of the pressure head is Neuman type boundary condition. For the soil water problem this condition means a specification of the flow through the boundaries

$$q(t) = - K(\Psi) \left(\frac{\partial \Psi}{\partial z} - 1\right)$$

(c) Mixed Condition

In this type a combination of the first two types are specified at the boundary. In particular this can specify

Ψ at the lower boundary

Ψ at the upper boundary

The actual flux across the soil surface is limited by the ability of the porous medium to transmit water through it. Similarly if the potential rate of infiltration exceeds the absorption capacity of the soil, part of the water will be lost by surface run-off. Here again the potential rate of infiltration is controlled by external conditions, whereas the actual flux depends on antecedent moisture conditions in the soil. Thus, the exact boundary condition to be assigned at the soil surface is not known a priori, but a solution must be sought by maximizing the absolute value of the flux (Hanks et al 1969).

If one takes q^* (z = o,t) as the maximum possible flux, the following expression must always be satisfied

$$|q^*(z = o,t)| \geq |q(z = o,t)| = |- K(\Psi)(\frac{\partial\Psi}{\partial z} - 1)|$$

Also during rainfall, the condition

$$\Psi(z = o,t) \leq 0 \qquad [\text{or } \theta(z = o,t) \leq \theta_s]$$

must hold where θ_s is the moisture content at saturation. During evaporation the requirement

$$\Psi(z = o,t) \leq \Psi_1$$

holds where Ψ_1 is the minimum pressure head to be allowed under air-dry conditions. According to Hillel, if the pressure head at the soil surface is at equilibrium with the atmosphere, then Ψ_1 can be derived from the well known relationship

$$\Psi_1 = \frac{RT}{Mg} \ln (F)$$

where R is the universal gas constant, T is the absolute temperature (°K), g is acceleration due to gravity, M is molecular weight of water and F is the relative humidity of air.

2.2 Green & Ampt Assumptions

The Green & Ampt solution is based on the assumption that there is instant ponding at the soil surface at the onset of rain. They also further assume that there is a wetting front (as shown in fig.2.2a) behind which the soil is completely saturated. Infront of the wetting front the soil moisture is equal to the initial soil moisture.

If Z_f is the saturation front at time, t, according to Green & Ampt

$$\text{for } Z < Z_f \quad \theta = \tilde{\theta} \quad \text{and} \tag{2.2.1}$$

$$\text{for } Z > Z_f \quad \theta = \theta_i$$

The Rechard's equation is given by

$$\frac{\partial \theta}{\partial t} + \frac{\partial Vw}{\partial z} = 0 \tag{2.2.2}$$

within the saturation front $\frac{\partial \theta}{\partial t} = 0$

This implies that

$$\frac{\partial Vw}{\partial z} = 0 \tag{2.2.3}$$

Thus velocity of water inside the saturation zone at any particular time is constant and is equal to the infiltration rate.

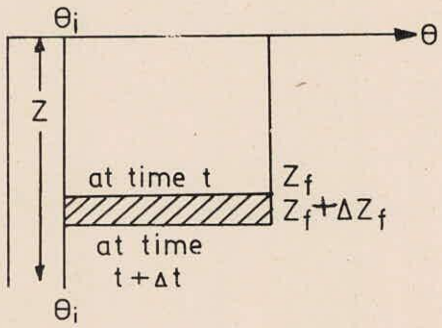

Fig.2.2a

Over a small interval of time Δt

$$I.\Delta t = (\tilde{\theta} - \theta_i)\, \Delta Z_f \tag{2.2.4}$$

or

$$I = (\tilde{\theta} - \theta_i)\frac{dz_f}{dt} \tag{2.2.5}$$

According to Green & Ampt (1911)

$$I = \tilde{K} \left[\frac{(H+H_f)(\tilde{\theta} - \theta_i) + Z_f(\tilde{\theta} - \theta_i)}{Z_f(\tilde{\theta} - \theta_i)} \right]$$

or

$$I = \frac{\tilde{K}(H_f+H+Z_f)}{Z_f} \qquad 2.2.6$$

where K is the saturated hydraulic conductivity, H_f is the effective capillary drive, H is the water depth on the soil surface during infiltration and Z_f is the depth to the sharp wetting front.

From equations (2.2.5 & 2.2.6)

$$\frac{Z_f \; dz_f}{(H+H_f+Z_f)} = \frac{\tilde{K} \; dt}{(\tilde{\theta} - \theta_i)} \qquad 2.2.7$$

Its integration leads to

$$Z_f - (H+H_f) \ln \left(\frac{H+H_f+Z_f}{H+H_f}\right) = \frac{\tilde{K} \, t}{\tilde{\theta} - \theta_i} \qquad 2.2.8$$

which gives the time 't' for the saturation front to reach a depth Z_f.

3.0 Statement of the Problem

An unsaturated soil layer is overlying a static water table as shown in fig.(3.1)before onset of a rainfall event. The soil moisture profile has attained the equilibrium soil moisture profile. The rain has high intensity which causes instantaneous ponding and the soil moisture at the surface attains saturation soil moisture. The rainfall intensity is sufficient to cause infiltration at capacity rate. It is required to predict soil moisture distribution with time at different depth using numerical method and by Green and Ampt approach. It is aimed to compare the infiltration quantities and the velocity of water calculated by both the approaches.

Assumptions

The assumption made for the analysis are as follows:

(a) When the rain starts, immediate ponding occurs.

(b) The upper boundary condition is assumed to satisfy the Dirichlet Type boundary condition.

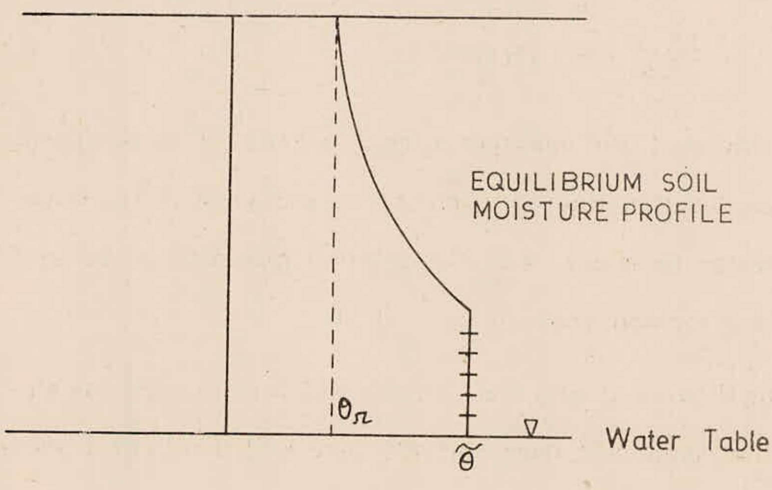

Fig.3.1

4.0 METHODOLOGY

4.1 Mathematical Model

The mathematical procedure which is used in the modelling of flow through unsaturated soil is well established. The differential equation which governs the flow of water in the unsaturated soil is given by the equation

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z} [D(\theta) \frac{\partial \theta}{\partial z}] - \frac{\partial K(\theta)}{\partial z} \qquad 4.1a$$

in which θ is the volumetric moisture content (cm^3/cm^3), t is time (day), z is depth (cm), $D(\theta)$ is the soil moisture diffusivity (cm^2/day), $K(\theta)$ is the hydraulic conductivity function (cm/day).

Solution of equation (1) satisfying a given initial and boundary condition would predict the spatial and temporal distribution of soil moisture in specific case.

4.1.1 Initial and boundary conditions

The upper boundary condition could be fixed by the following equation given by Hillel (1977)

$$h(o,t) = \frac{RT(t)}{Mg} \ln [f(t)] \qquad 4.1.1a$$

where R is the universal gas constant (ergs/mole/K), T is temperature (°K), g is the acceleration due to gravity (cm/sec^2), M is the molecular weight of water (g/mole), f is the relative humidity of air and h is the soil moisture tension (bars).

Knowing h(o,t) at any time t, the moisture content at the soil surface can be calculated from soil moisture and capillary pressure relationship. However as it has been assumed that there is instantaneous ponding, $\theta(o,t) = \tilde{\theta}$.

At the water table, the soil will be completely saturated and $\theta = \tilde{\theta}$ forms the lower boundary condition. The initial condition can be fixed in the following manner. If the ground water table is fixed at a particular level, the soil moisture profile due to capillary rise will establish and the equilibrium soil moisture profile can be taken as initial condition in the absence of a record of soil moisture distribution with depth at a specific time.

4.1.2 Explicit formulation for governing equation

The Explicit formulation of equation (2.1) is

$$\frac{\theta(i,j) - \theta(i,j-1)}{\Delta t} = [fD(\theta(i,j-1) + (1-f)D(\theta(i-1,j-1))]$$

$$\frac{\theta(i+1,j-1) - 2\theta(i,j-1) + \theta(i-1,j-1)}{\Delta Z^2} + \frac{\theta(i,j-1) - \theta(i-1,j-1)}{\Delta Z} \cdot$$

$$\frac{D(\theta(i,j-1) - D(\theta(i-1,j-1))}{\Delta Z} - \frac{K(\theta(i,j-1)) - K(\theta(i-1,j-1))}{\Delta Z}$$

4.1.2a

After rearranging the terms, one gets

$$\theta(i,j) = \theta(i,j-1) + \Delta t \{ fD(\theta(i,j-1) + (1-f)D(\theta(i-1,j-1))\}$$

$$\frac{\theta(i+1,j-1) - 2\theta(i,j-1) + \theta(i-1,j-1)}{\Delta Z^2} +$$

$$\Delta t. \frac{\theta(i,j-1) - \theta(i-1,j-1)}{\Delta Z} \cdot \frac{D(\theta(i,j-1) - D(\theta(i-1,j-1))}{\Delta Z}$$

$$- \frac{\Delta t}{\Delta z} [K(\theta(i,j-1)) - K(\theta(i-1,j-1))] \qquad 4.1.2b$$

The moisture content $\theta(i,j)$ at the node i and at time j can be solved using the above explicit relationship for given boundary conditions.

4.2 Green & Ampt Equation

The temporal and spatial variation of soil moisture can be obtained for Ponded Condition by Green & Ampt equation. According to Green & Ampt equation the position of saturation front at time t is given by

$$Z_f - (H+H_f) \ln \left(\frac{H+H_f+Z_f}{H+H_f}\right) = \frac{\tilde{K}t}{\tilde{\theta}-\theta} \qquad 4.2a$$

in which

Z_f = depth to saturation front,

H = ponded depth of water,

$\tilde{K}$ = saturated hydraulic conductivity,

$\tilde{\theta}$ = moisture content at saturation,

θ_i = initial moisture content, and

H_f = the capillary drive head.

The capillary drive head can be found from the available soil moisture and capillary pressure relationship in the following manner as suggested by Bouwer:

$$H_f = \int_0^{h_{c_i}} k_{rw}(\theta)\, dh_c \qquad 4.2b$$

where $k_{rw}(\theta) = \frac{K(\theta)}{\bar{K}(\theta)}$ = relative permeability of water,

h_c = capillary pressure head, and

h_{c_i} = capillary pressure head corresponding to the initial soil moisture θ_i prevailing before the onset of infiltration. The relationship between relative permeability versus moisture content and capillary rise, h_c, versus $k_{rw}(\theta)$ have been given by Fig.4 & Fig.5.

4.3 Velocity of Water

Let at time t, at depth Z_1, the moisture content be θ_1 and at depth $Z_2 (Z_2 = Z_1+\Delta Z)$, the moisture content be θ_2. Let the capillary pressure head corresponding to θ_1 be p_{c_1} and the capillary head corresponding to θ_2 be p_{c_2}

From Darcy's Law the velocity of water at time t at depth Z is given by

$$V_z = - K(\theta) \frac{(-p_{c_2}/r_w - Z_2) - (-p_{c_1}/r_w - Z_1)}{\Delta Z} \qquad 4.3a$$

If Z_f is depth to the saturation front at time t, according to Green & Ampt equation

$$V_z = - \tilde{K} \frac{(H+H_f+Z_f)}{Z_f} \qquad 4.3b$$

where Z_f is given by equation (4.2a). The velocity is same from surface to depth Z_f at a given time.

5.0 COMPUTER PROGRAMME DESCRIPTION

The computer programme coded in fortran IV is implemented on VAX-11. In consists of a main programme and two subroutines. In the following steps these are described in sufficient detail to facilitate the running of the programme. The listing of the computer programme is given in Appendix-A.

5.1 Main Programme

The main programme reads the following parameters, required for simulation run

5.1.1 Capillary pressure head at upper boundary

To calculate the value of capillary pressure head at upper layer, the values of temperature and relative humidity have to be given. The values of capillary rise in milibar is equal to the cm. height of water. After knowing h_c, $\theta(o,t)$ can be read by the graph (Fig.1).

5.1.2 Upper boundary condition

During rainfall the moisture content $\theta(o,t) = \tilde{\theta}$.

5.1.3 Initial moisture content

At all nodes, the moisture content has been assigned the values corresponding equilibrium soil moisture profile (Fig.1).

5.1.4 Field capacity

The field capacity has been taken as .2 (cm^3/cm^3).

5.2 Subroutine 'BA'

This subroutine is called at each time step. It calculates the moisture content at the soil surface according to the calculated value of capillary rise in the main programme.

5.3 Subroutine DKK

This subroutine is also called at each time step. It calculates the diffusivity and hydraulic conductivity for each value of moisture content, which are being used in the algebraic equations in the main programme. The values of diffusivity and hydraulic conductivity at some fixed values of moisture content is given for a clayey type of soil. Interpolation technique has been used to find out the accurate values of diffusivity and conductivity for different values of moisture contents.

6.0 DATA USED

The input data for this model are as follows

1. The given temperature and relative humidity for every hour have been recorded by the apparatus in meterological lab.
2. Rainfall data is in cm. per hour.
3. In this model 1000 cm. soil profile was considered and was divided into 101 layers each 10 cm deep.
4. The initial soil moisture content θ_i and saturation moisture content θ are taken to be 0.2 and 0.49 respectively keeping in view of the equilibrium soil moisture profile.
5. Relation between moisture content and diffusivity and with hydraulic conductivity are represented by Fig.2 and Fig.3 for same soil. The values of diffusivity and conductivity have been given according to the moisture content in the main programme. These values are used in a subroutine to find out the exact value of diffusivity and conductivity for calculated values of moisture content at every time step.
6. The value of $\tilde{K}$ for this clay is taken as .02844 by Fig.3.
7. For θ_i = 0.2 the value of H_f was found to be 39.5 cm from Fig.5.

7.0 Results & Discussions

The moisture contents at each node at different times obtained by the explicit finite difference method making use of equation (4.1.2b). The variation of moisture content with depth and time has been shown in Fig.6. The area under each curve that represent soil moisture profile at a particular time has been measured by a planimeter and the equivalent saturation front corresponding piston type of flow has been obtained. The saturation for the same soil moisture characteristics has also obtained by Green & Ampt equation. The comparision of saturation fronts with time obtained by both the methods has been given in Table 1 and Figure 7. It could be seen that the time taken to reach a particular depth by the saturation front is under estimated by Green and Ampt equation, which means Green and Ampt would predict more infiltrated volume upto a particular time. As the rainfall continues, the time difference between the two methods increases.

The velocity distribution with depth at t = 48 & 72 hours have been shown in Fig.8. The soil moisture data which have been used in the present study is for a clayey type of soil. Therefore, the infiltration rate will be small. For this reason long duration rainfall has been considered. The velocity computed by Green and Ampt is fictitious and there is significant difference in the velocity distribution as computed by both the methods.

8.0 Conclusions

From the study of infiltration through clayey type of soil. It is found that the cumulative infiltrated volume upto any time calculated by numerical method and by Green & Ampt equation are comparable. However, the study should be extended for other type of soil. For study of soil moisture movement numerical method should be used if the distribution velocity with depth is a dominant factor, as the velocity in Green & Ampt approache remains invariant with depth upto the saturation front at any time. Koutitas (1983) gives the numerical solution of mathematical models of diffusion and dispersion. According to him, the use of an explicit scheme requires the simultaneous satisfaction of two stability criteria,

$$\theta \frac{\Delta t}{\Delta z} \leqq 1 \qquad (8.1)$$

and

$$D \frac{\Delta t}{\Delta z^2} \leqq \frac{1}{2} \qquad (8.2)$$

For the present study moisture content at the saturation = 0.49. The time step used = 1 hr. and Δz = 10 cm and maximum D = 28.33 cm^2/hour. Thus

$$\frac{\Delta t}{\Delta z} = \cdot 49 \times \frac{1}{10} \leqq 1 \qquad (8.3)$$

and

$$D \frac{\Delta t}{\Delta z^2} = 28.33 \times \frac{1}{100} \leqq \frac{1}{2} \qquad (8.4)$$

The use of a finite difference scheme containing a rate of numerical diffusion in excess of the diffusion implied by the diffusion coefficients 'D' introduces errors to the numerical system. For this reason the explicit scheme has been used in this study.

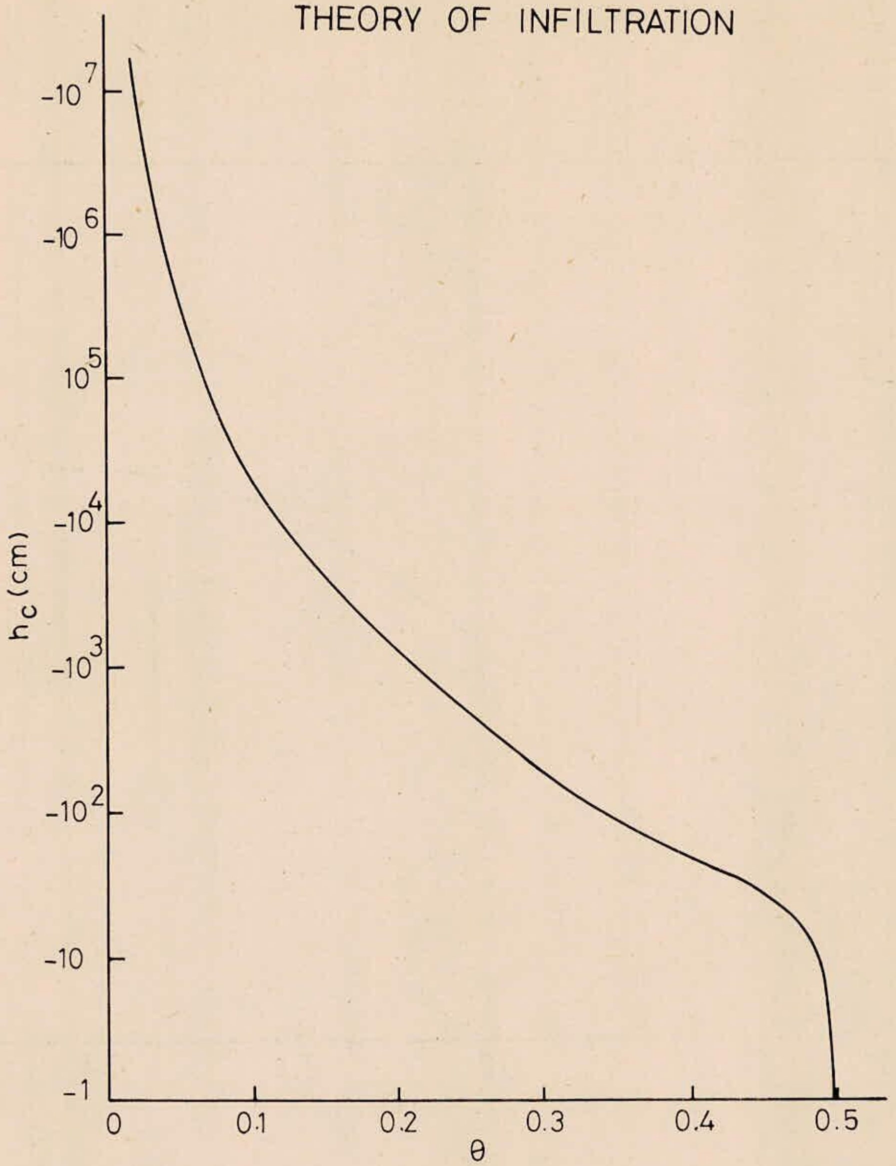

FIG.1 RELATIONSHIP BETWEEN CAPILLARY RISE, h_c, AND MOISTURE CONTENT, θ, FOR A CLAYEY TYPE OF SOIL

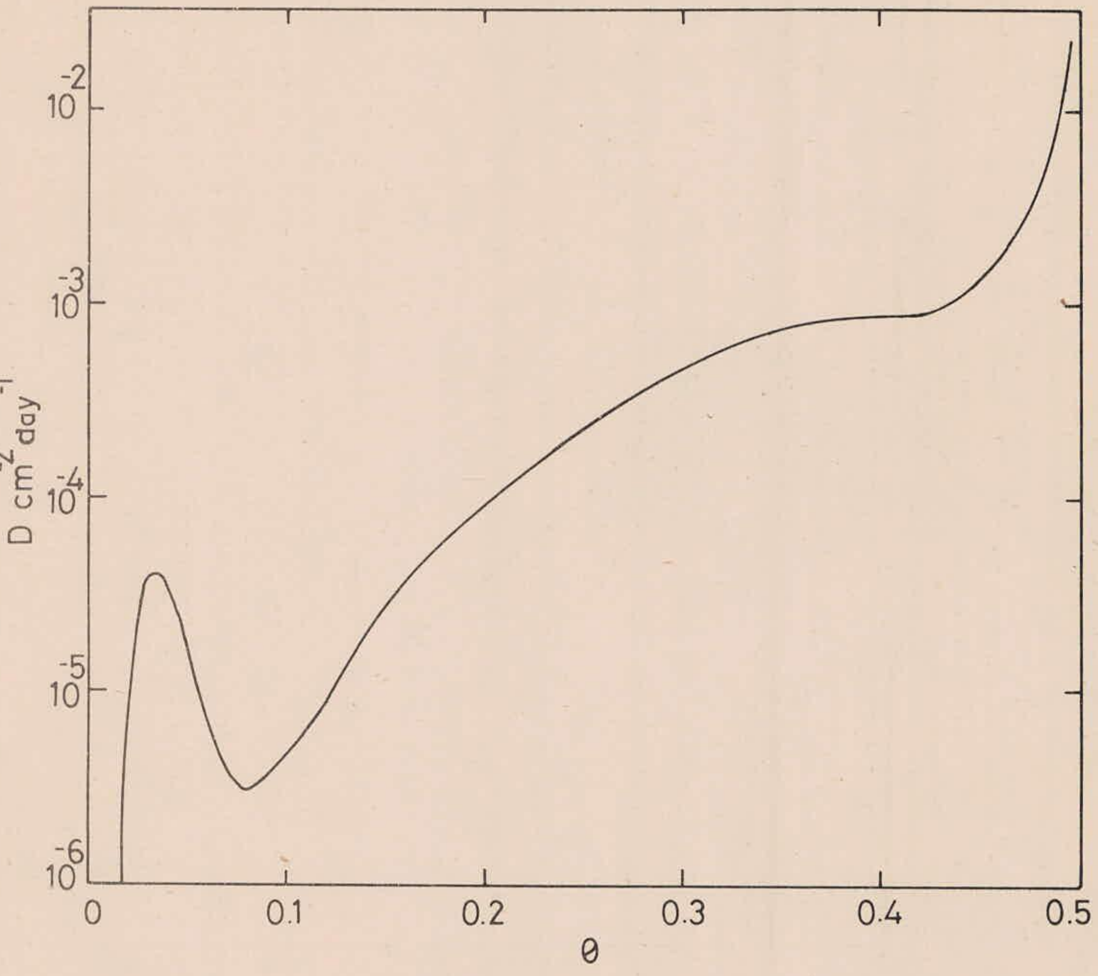

FIG.2 RELATIONSHIP BETWEEN MOISTURE DIFFUSIVITY, D, AND MOISTURE CONTENT, θ, FOR A CLAYEY TYPE OF SOIL

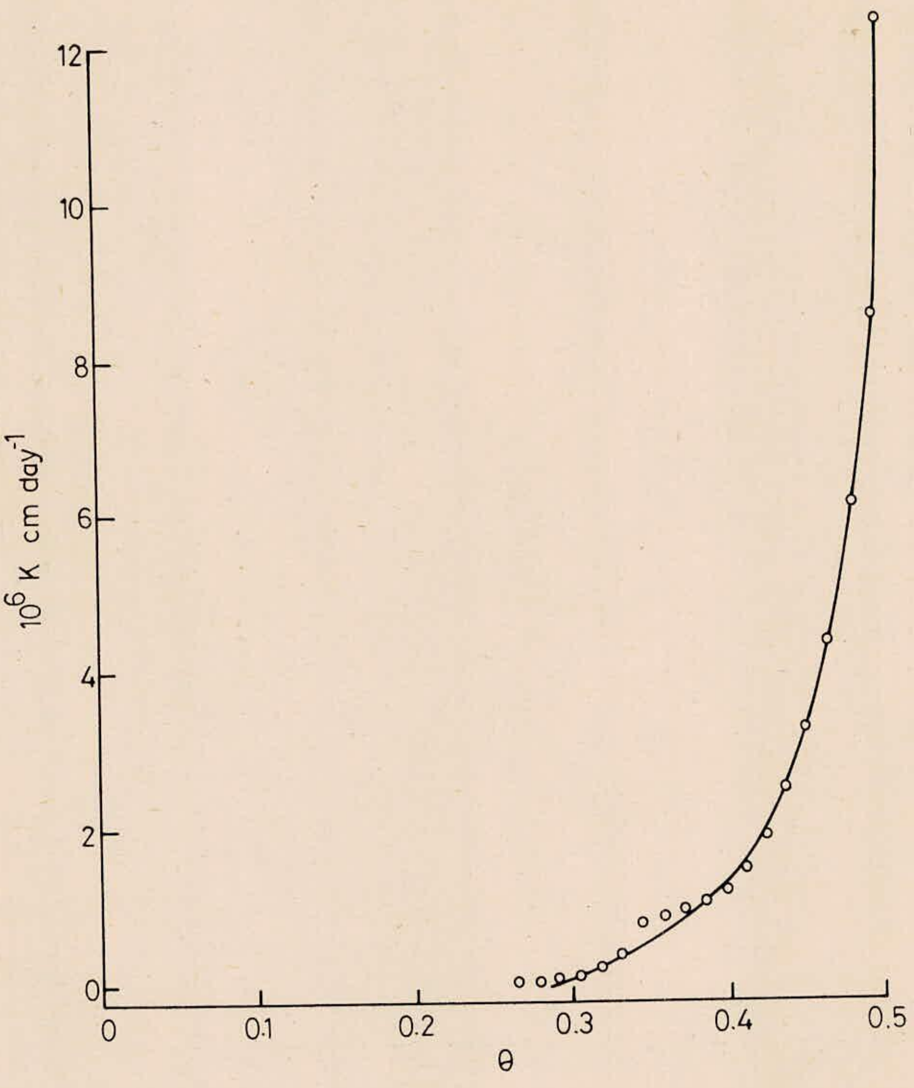

FIG. 3 RELATIONSHIP BETWEEN HYDRAULIC CONDUCTIVITY, K, AND MOISTURE CONTENT, θ, FOR A CLAYEY TYPE OF SOIL

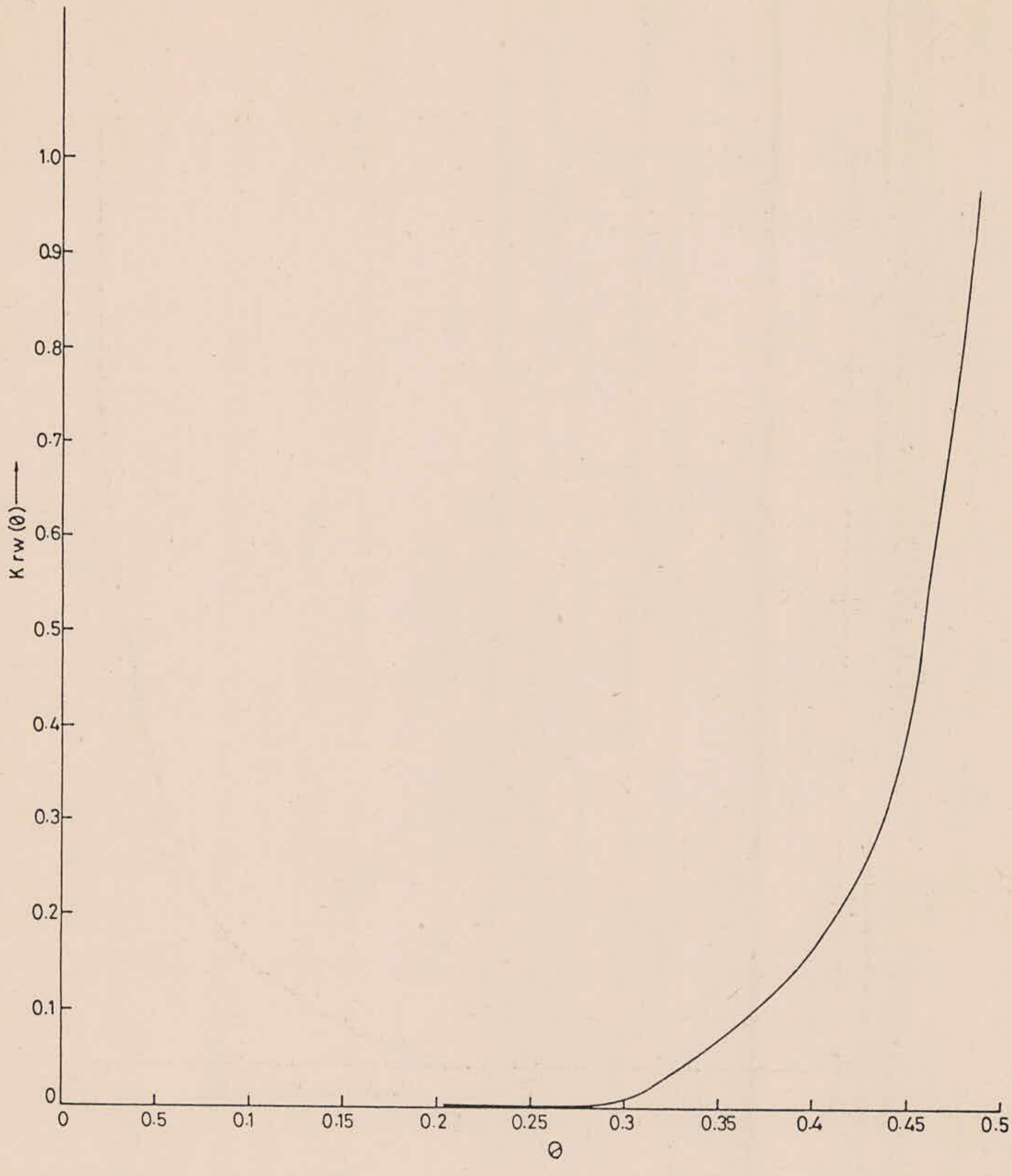

FIG.4 RELATIONSHIP BETWEEN RELATIVE PERMEABILITY, $k_{rw}(\theta)$, AND MOISTURE CONTENT (θ)

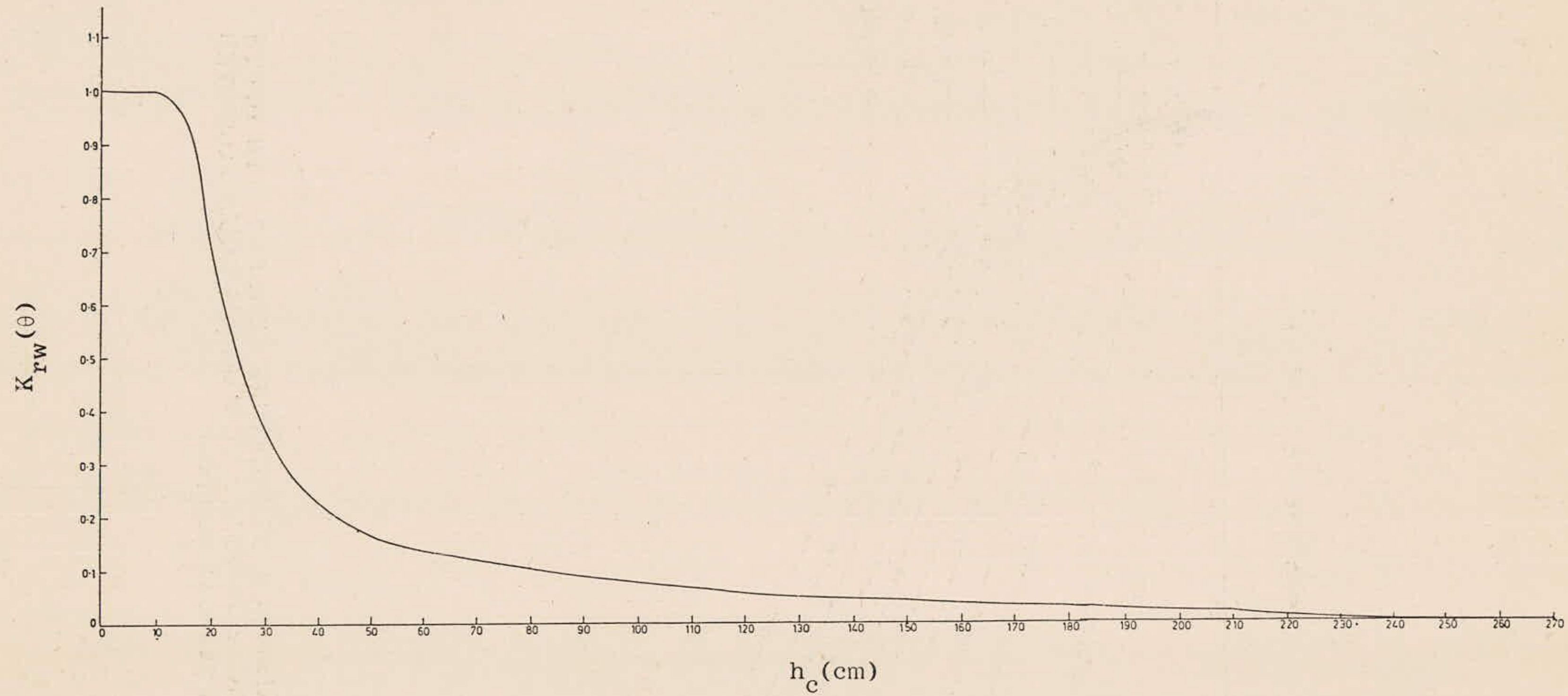

FIG.5 VARIATION OF RELATIVE PERMEABILITY ($k_{rw}(\theta)$) VERSUS CAPILLARY RISE (h_c)

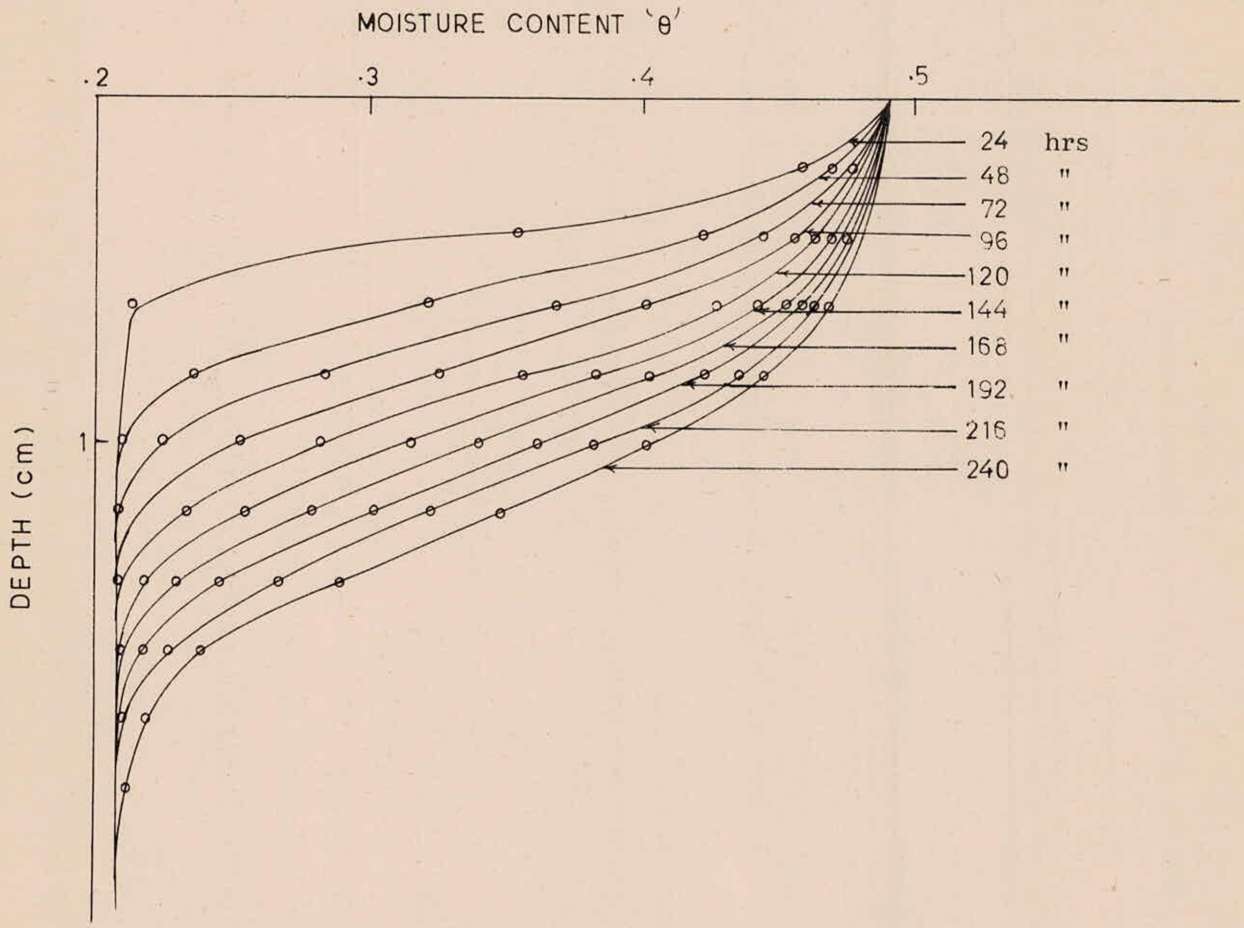

FIG. 6 DISTRIBUTION OF MOISTURE CONETNT WITH DEPTH DURING A RAINFALL AT VARIOUS TIMES COMPUTED BY NUMERICAL METHOD

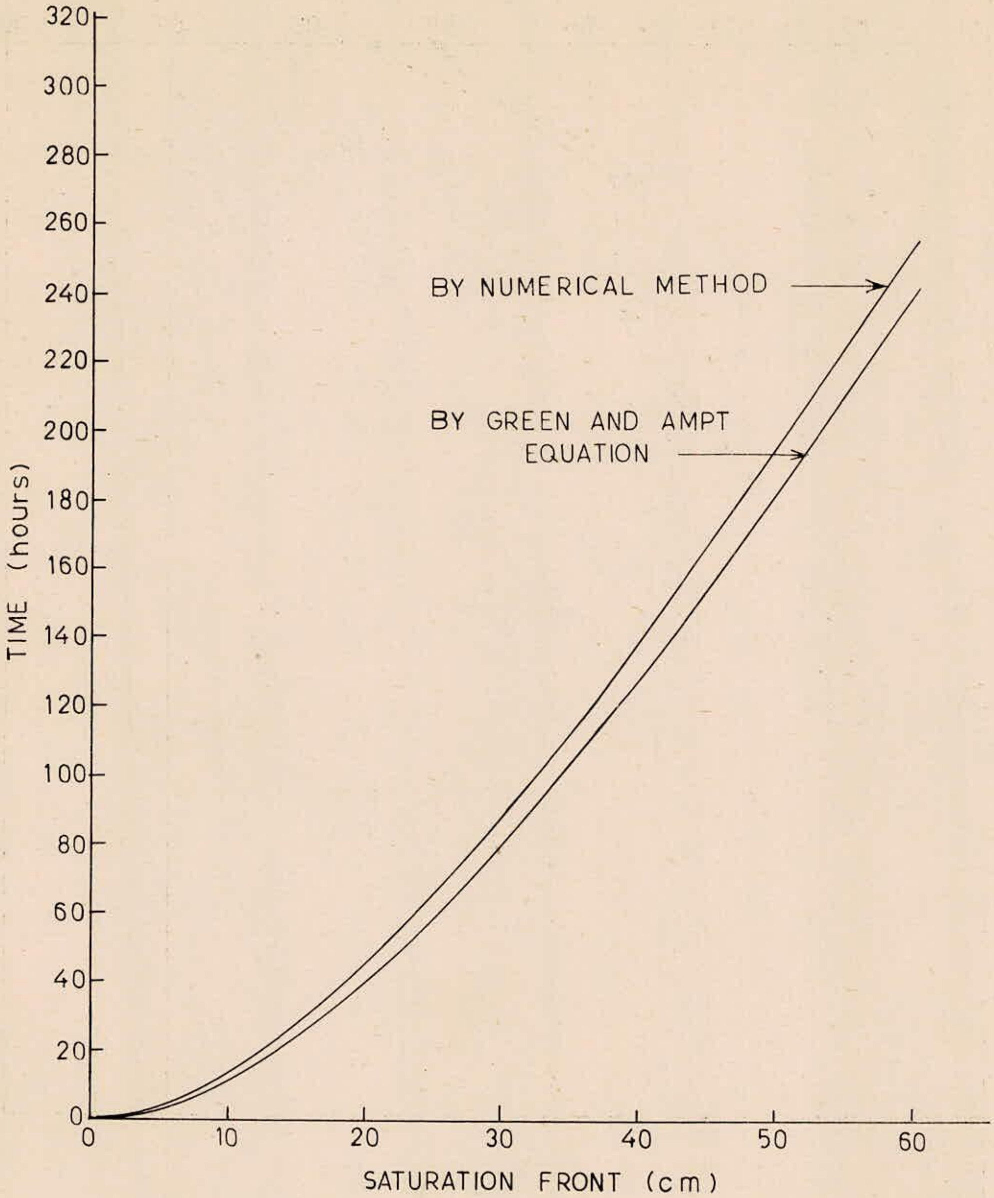

FIG.7 COMPARISION OF SATURATION FRONTS AT DIFFERENT TIMES COMPUTED BY NUMERICAL METHOD AND GREEN & AMPT EQUATION

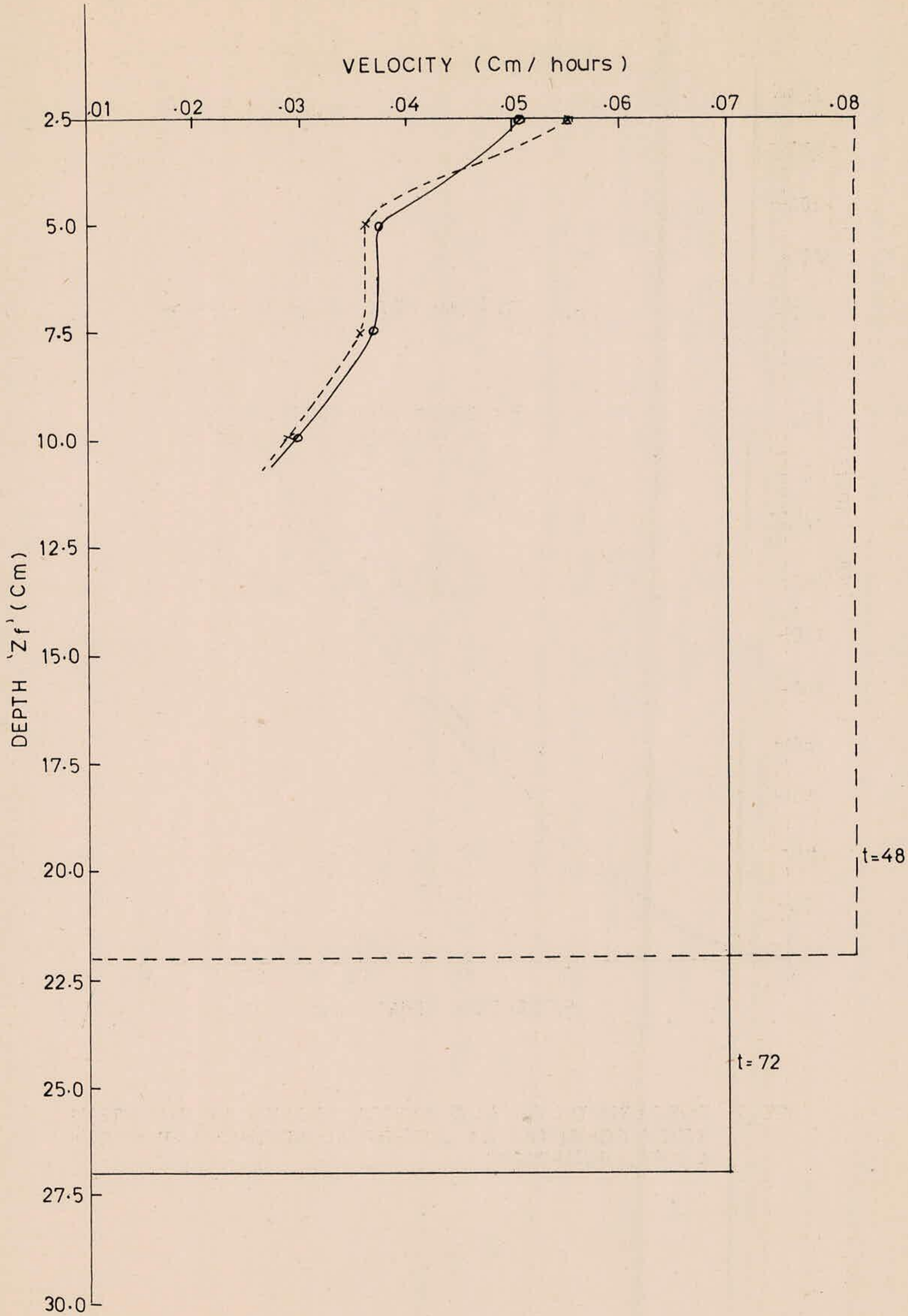

FIG.8 VARIATION OF VELOCITY WITH DEPTH FOR DIFFERENT TIMES COMPUTED BY GREEN & AMPT EQUATION AND NUMERICAL MODEL

Table 1 Comparison of saturation fronts at different times computed by numerical method and Green & Ampt equation

Saturation front (cm)	Times taken to reach the saturation front by numerical method (hours)	Times taken to reach the saturation front by Green & Ampt equation (hours)
14	24	20
21	48	42
27	72	65
32	96	87
41	120	111
45	168	152
50	192	180
54	216	203
58	240	227

Table 2 Velocities at different depth at a particular time computed by numerical method

Particular time (hours)	Velocities at different depths by numerical model (cm/hour)	Depths from upper boundary (cm)
t = 48	.055099	2.5
	.03638	5
	.036	7.5
	.02996	10
t = 72	.05124	2.5
	.03724	5
	.0369	7.5
	.02986	10

Table 3 Velocity computed by Green & Ampt equation at a particular time

Particular times (hour)	Velocities at saturation fromt (cm/hour)	Saturation Depth 'Z_f' (cm)
t = 48	.08193	21
t = 72	.07004	27

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C                     APPENDIX - A
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C     .    PROGRAMME FOR SOIL MOISTURE PROFILE IN CLAYEY TYPE  .
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C        PROGRAMME FOR SOIL MOISTURE CONTENTS
C        MODEL BY EXPLICIT FORMULATION
C        DELT=INCREMENT IN TIME
C        DELZ=INCREMENT IN DEPTH(CMS.)
C        NZ=NO. OF NODE POINTS
C        NBC=NO. OF BOUNDRY CONDITIONS
C        NTIM=NO. OF TIME STEPS
C        FC=FIELD CAPACITY (CC/CC)
C        RN=RAINFALL(CMS.)
C        STHETA=MOISTURE CONTENT AT THE SOIL SURFACE(CC/CC)
C        TH=VALUE OF MOISTURE CONTENT (THETA) AT (J-1)th TIME(CC/CC)
C        TTH=VALUE OF MOISTURE CONTENT(THETA) AT Jth TIME(CC/CC)
C        DTH=DIFFUSIVITY AT MOISTURE CONTENT ,TH (CM.SQUARE/DAY)
C        KTH=HYDRAULIC CONDUCTIVITY AT MOISTURE CONTENT ,TH (CM./DAY)
C        SS=TOTAL MOISTURE CONTENT IN THE SOIL PROFILE (CMS.)
C        DEFT=TOTAL MOISTURE DEFICIT IN THE SOIL PROFILE (CMS)
C        W=MOLECULAR WEIGHT OF WATER(GM/MOLE)
C        G=ACCELARATION DUE TO GRAVITY(CM/SEC SQU.)
C        R=UNIVERSAL GAS CONSTANT(ERGS/MOLE/K)
C        T=TEMPERATURE(O KELVIN)
C        F=RELATIVE HUMIDITY
C        H=CAPPILARY RISE OF WATER(CM.)
         PARAMETER (MM=250)
         DIMENSION TH(MM),STHETA(MM),HC(0:MM)
         DIMENSION RN(MM),T(MM),F(MM),H(MM),D(0:MM),AK(0:MM),DTT(MM)
        1,ATH(MM),TT(MM),DT(MM),AKT(MM),ATT(MM),ATHETA(0:MM),AKTT(MM)
        2,THETA(0:MM),TTH(MM)
         OPEN (UNIT=1,FILE='SS.DAT',STATUS='OLD')
         OPEN(UNIT=2,FILE='SS.OUT',STATUS='NEW')
         G=981.
         DELT=1.0
         DELZ=10.00
         W=18.
         NZ=101
         NBC=2
         NP=NZ-NBC
         NTIM=240
         R=8.30E+7
         B=DELT/DELZ
C        THIS IS THE SATURATED THETA AT LOWER SURFACE.
         SATHETA=0.49
         NK=NZ-1
         FC=0.2
         WRITE(2,882)
         READ(1,*) (T(J),J=1,NTIM)
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C       WRITE(2,*)(T(J),J=1,NTIM)
        READ(1,*) (TH(I),I=2,NK)
C       WRITE(2,*)(TH(I),I=2,NK)
        READ(1,*) (RN(J), J=1,NTIM)
C       WRITE(2,*)(RN(J), J=1,NTIM)
        READ(1,*) (F(J),J=1,NTIM)
C       WRITE(2,*)(F(J),J=1,NTIM)
        READ(1,*) (HC(N),N=1,101)
C       WRITE(2,*)(HC(N),N=1,101)
        READ(1,*) (THETA(N),N=1,101)
C       WRITE(2,*)(THETA(N),N=1,101)
        READ(1,*) (ATHETA(N),N=1,59)
C       WRITE(2,*)(ATHETA(N),N=1,59)
        READ(1,*) (D(N),N=1,59)
C       WRITE(2,*)(D(N),N=1,59)
        READ(1,*) (AK(N),N=1,59)
C       WRITE(2,*)(AK(N),N=1,59)
C       CHANG AK(I) FOR CM. /DAY
        DO 45 I=1,59
        AK(I)=(AK(I)*1.E-6)*3600.
C       WRITE(2,*) ATHETA(I),D(I),AK(I)
  45    CONTINUE
        DO 5 J=1,NTIM
C       CALCULATION FOR CAPPILARY RISE
        TT(J)=T(J)+273.
        H(J)=(R*TT(J)*ALOG(F(J)/100))/(W*G)
C       H(J) IS IN DYNE/CM*CM
C       CONVERT H(J) IN BAR
        H(J)=H(J)/(1.0E+6)
C       CONVERT H(J) IN MILIBAR
        H(J)=H(J)*(1.0E+3)
C       H(J) IN MILIBAR IS EQUAL TO CM. HEIGHT OF WATER
C       THIS SUBROUTINE CALCULATE THE THETA AT SURFACE AS STHETA
        H(J)=ABS(H(J))
        CALL BA(H,J,STHETA,MM,HC,THETA)
C       WRITE(2,*) H(J),STHETA(J),J
C       UPPER BOUNDARY CONDITION
        TH(1)=STHETA(J)
C       LOWER BOUNDARY CONDITION
        TH(NZ)=SATHETA
C       ADJUSTMENT FOR RAINFALL
C       IMMIDIATE PONDING
        IF(RN(J).LE.0.0) GO TO 65
        TH(1)=SATHETA
  65    CONTINUE
        SS=0.0
        DO 50 I=2,NK
        L=I+1
        KK=I-1
C       THIS SUBROUTINE CALCULATES DIFFUSIVITY & CONDUCTIVITY AT TH(I & L )
        CALL DKK(TH,DTT,AKTT,KK,I,L,ATHETA,D,AK,N,MM)
        DT(KK)=DTT(3)
        AKT(KK)=AKTT(3)
        DT(I)=DTT(1)
        AKT(I)=AKTT(1)
        DT(L)=DTT(2)
        AKT(L)=AKTT(2)
        TTH(I)=TH(I)+B*(.75*DT(I)+.25*DT(KK))*(TH(L)-2.*TH(I)+TH(KK))/DELZ
       1+B*(TH(I)-TH(KK))*(DT(I)-DT(KK))/DELZ-(AKT(I)-AKT(KK))/DELZ
  50    CONTINUE
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      DO 67 I=2,NK
67    TH(I)=TTH(I)
      IF(J.EQ.24.OR.J.EQ.48.OR.J.EQ.72.OR.J.EQ.96.OR.J.EQ.120)GO TO 44
      IF(J.EQ.144.OR.J.EQ.168.OR.J.EQ.192.OR.J.EQ.216.OR.J.EQ.240)GO TO 44
      GO TO 5
44    WRITE(2,906) J
      WRITE(2,*) (TH(I),I=1,NZ)
C     CALCULATION FOR MOISTURE CONTENT AT NODES
      DO 75 I=1,NK
      KL=I+1
      ATT(I)=(TH(I)+TH(KL))*0.5*10
75    SS=SS+ATT(I)
C     CALCULATION FOR MOISTURE DEFICIT
      DEFT=FC*1000-SS
      WRITE(2,907) SS,DEFT
5     CONTINUE
882   FORMAT(10X,'APPENDIX A'/)
106   FORMAT(6X,'TOTAL INITIAL MOISTURE CONTENT='F18.8,1X,'Cms.')
579   FORMAT(46X,'TOTAL DRAINAGE='F18.8,1X,'Cms.'/)
906   FORMAT(6X,'TIME STEP=',I3)
907   FORMAT(1X,'TOTAL MOISTURE CONTENT='F18.8,1X,'Cms.'/2X,'TOTAL
     1 MOISTURE DEFICIT='F18.8,1X,'Cms.')
      STOP
      END
      SUBROUTINE BA(H,J,STHETA,MM,HC,THETA)
C     IT CALCULATES SURFACE THETA ACCORDING TO HC
      DIMENSION THETA(0:MM),HC(0:MM),STHETA(MM),H(MM)
      HC(0)=0.0
      THETA(0)=0.0
      DO 20 I=1,101
      IF(H(J).EQ.HC(I)) GO TO 25
      IF(H(J).GT.HC(I-1).AND.H(J).LT.HC(I)) GO TO 15
      GO TO 20
25    STHETA(J)=THETA(I)
15    STHETA(J)=THETA(I-1)+(THETA(I)-THETA(I-1))*
     1((H(J)-HC(I-1))/(HC(I)-HC(I-1)))
20    CONTINUE
      RETURN
      END
      SU ROUTINE DKK(TH,DTT,AKTT,KK,K,L,ATHETA,D,AK,N,MM)
C     IT CALCULATES DIFFUSIVITY & H. CONDUCTIVITY FOR M. C.
      DIMENSION ATHETA(0:MM),D(0:MM),AK(0:MM),DTT(MM),AKTT(MM),THH(3)
     2,TH(MM)
      THH(1)=TH(K)
      THH(2)=TH(L)
      THH(3)=TH(KK)
      ATHETA(0)=0.0
      D(0)=0.0
      AK(0)=0.0
      DO 30 I=1,3
      DO 20 J=1,59
      IF (THH(I).EQ.ATHETA(J))GO TO 10
      IF(THH(I).LT.ATHETA(J).AND.THH(I).GT.ATHETA(J-1))GO TO 15
      GO TO 20
15    DTT(I)=D(J-1)+(D(J)-D(J-1))*
     1((THH(I)-ATHETA(J-1))/(ATHETA(J)-ATHETA(J-1)))
      AKTT(I)=AK(J-1)+(AK(J)-AK(J-1))*
     1((THH(I)-ATHETA(J-1))/(ATHETA(J)-ATHETA(J-1)))
      GO TO 30
10    DTT(I)=D(J)
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      AKTT(I)=AK(J)
      GO TO 30
20    CONTINUE
30    CONTINUE
      RETURN
      END
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TEST INPUT

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240*24.0
.21     .21     .2105   .211    .2115   .212    .2125   .213
.2135   .214    .2145   .215    .216    .217    .2175   .218
.219    .22     .2205   .221    .2215   .222    .223    .225
.2256   .226    .2265   .227    .2285   .23     .2305   .231
.232    .233    .2345   .236    .237    .238    .239    .24
.241    .242    .2435   .245    .247    .2485   .2495   .25
.251    .253    .254    .255    .256    .26     .2605   .261
.262    .264    .266    .268    .27     .272    .2748   .275
.2765   .278    .28     .282    .2835   .285    .287    .29
.294    .296    .298    .3      .302    .305    .31     .3125
.315    .32     .323    .325    .33     .335    .338    .342
.35     .355    .362    .37     .38     .39     .402    .42
.442    .47     .49
240*2.5
240*86
1   10  20  30  40  50  60  70  80  90  100 110 120
130 140 150 160 170 180 190 200 210 220 230 240 250
260 270 280 290 300 310 320 330 340 350 360 370 380
390 400 410 420 430 440 450 460 470 480 490 500 510
520 530 540 550 560 570 580 590 600 610 620 630 640
650 660 670 680 690 700 710 720 730 740 750 760 770
780 790 800 810 820 830 840 850 860 870 880 890 900
910 920 930 940 950 960 970 980 990 1000
0.49 0.49  0.4700000  0.4420000  0.4200000  0.4020000
0.3900000  0.3800000  0.3700000  0.3620000  0.3550000
0.3500000  0.3420000  0.3380000  0.3350000  0.3300000
0.3250000  0.3230000  0.3200000  0.3150000  0.3125000
0.3100000  0.3050000  0.3020000  0.3000000  0.2980000
0.2960000  0.2940000  0.2900000  0.2870000  0.2850000
0.2835000  0.2820000  0.2800000  0.2780000  0.2765000
0.2750000  0.2748000  0.2720000  0.2700000  0.2680000
0.2660000  0.2640000  0.2620000  0.2610000  0.2605000
0.2600000  0.2560000  0.2550000  0.2540000  0.2530000
0.2510000  0.2500000  0.2495000  0.2485000  0.2470000
0.2450000  0.2435000  0.2420000  0.2410000  0.2400000
0.2390000  0.2380000  0.2370000  0.2360000  0.2345000
0.2330000  0.2320000  0.2310000  0.2305000  0.2300000
0.2285000  0.2270000  0.2265000  0.2260000  0.2256000
0.2250000  0.2230000  0.2220000  0.2215000  0.2210000
0.2205000  0.2200000  0.2190000  0.2180000  0.2175000
0.2170000  0.2160000  0.2150000  0.2145000  0.2140000
0.2135000  0.2130000  0.2125000  0.2120000  0.2115000
0.2110000  0.2105000  0.2100000  0.2100000  0.2100000
.2    .205  .21   .215  .22   .225  .23   .235  .24   .245
.25   .255  .26   .265  .27   .275  .28   .285  .29   .295
.30   .305  .31   .315  .32   .325  .33   .335  .34   .345
.35   .355  .36   .365  .37   .375  .38   .385  .39   .395
.40   .405  .41   .415  .42   .425  .43   .435  .44   .445
.45   .455  .46   .465  .47   .475  .48   .485  .49
0.32707   .36874   .41569   .44673    .48006  .5284   .58161
0.62501   .67161   .73927   .81374    .87441  .9397   1.00976
1.08507o  1.16605  1.253052 1.34654   1.4469  1.55496 1.670976
1.7530    1.8392   1.9296   2.0244    2.12392 2.22829 2.33777
2.4526    2.57337  2.6996   2.7651    2.83226 2.936   3.04358
3.0803    3.11745  3.1320   3.1475    3.17025 3.19312 3.2316
3.2706    3.35005  3.4314   3.51468   3.6     3.7769  3.9625
4.36215   4.8006   5.5437   6.4015    7.75609 9.397   11.9436
15.1808 20.7357 28.32278
1E-10   1E-10   1E-10   1E-10   1E-10   1E-10   1E-10   1E-10
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1E-10	1.5E-10	2E-10	2E-10	2E-10	2E-10	2E-10	2E-10
2E-10	4.99E-03	.001	.03	.05	.075	.15	.19
.24	.29	.35	.4	.45	.5	.55	.6
.66	.77	.8	.9	1.0	1.1	1.15	1.2
1.3	1.5	1.6	1.7	1.85	2.06	2.2	2.5
2.75	3.05	3.3	3.8	4.3	4.7	5.2	5.8
6.27	7.28	7.9					

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    TIME STEP= 24
0.4900000       0.4576162       0.3574477       0.2448514       0.2121478
0.2115170       0.2120006       0.2125004       0.2130004       0.2135004
0.2140004       0.2145028       0.2150489       0.2160013       0.2169518
0.2175004       0.2180507       0.2190013       0.2199498       0.2204980
0.2210007       0.2215039       0.2220602       0.2231058       0.2248557
0.2255704       0.2260105       0.2265083       0.2271177       0.2285047
0.2298832       0.2304971       0.2310629       0.2320101       0.2330660
0.2345042       0.2359387       0.2369979       0.2380020       0.2390021
0.2400025       0.2410086       0.2420760       0.2435180       0.2450771
0.2469339       0.2484154       0.2494232       0.2500899       0.2511614
0.2528549       0.2539920       0.2550485       0.2564763       0.2594440
0.2604547       0.2611106       0.2622033       0.2640323       0.2660152
0.2680155       0.2700290       0.2721226       0.2743089       0.2752247
0.2765519       0.2781254       0.2800128       0.2818858       0.2835027
0.2851628       0.2873302       0.2902495       0.2934218       0.2958475
0.2979460       0.3000070       0.3022984       0.3053594       0.3089917
0.3122660       0.3154570       0.3192041       0.3225240       0.3256868
0.3297507       0.3341479       0.3382586       0.3430689       0.3490938
0.3552999       0.3621754       0.3703506       0.3794186       0.3903360
0.4034627       0.4202888       0.4401354       0.4620307       0.4791183
0.4900000
TOTAL MOISTURE CONTENT=         277.11093140 Cms.
 TOTAL MOISTURE DEFICIT=         -77.11093140 Cms.
    TIME STEP= 48
0.4900000       0.4707281       0.4224006       0.3211114       0.2368358
0.2127278       0.2120316       0.2125014       0.2130007       0.2135007
0.2140013       0.2145093       0.2150889       0.2160024       0.2169133
0.2175012       0.2180915       0.2190024       0.2199095       0.2204918
0.2210015       0.2215132       0.2221179       0.2231816       0.2247485
0.2255345       0.2260166       0.2265278       0.2272105       0.2285079
0.2297941       0.2304894       0.2311116       0.2320319       0.2331183
0.2345077       0.2358929       0.2369896       0.2380029       0.2390043
0.2400063       0.2410246       0.2421361       0.2435492       0.2451268
0.2468839       0.2483385       0.2493712       0.2501619       0.2512658
0.2527764       0.2539819       0.2551391       0.2567290       0.2591276
0.2603695       0.2612004       0.2623589       0.2640881       0.2660368
0.2680351       0.2700610       0.2721292       0.2740618       0.2752956
0.2766316       0.2782142       0.2800238       0.2818296       0.2835238
0.2853219       0.2875777       0.2903368       0.2931401       0.2956493
0.2978791       0.3000565       0.3024762       0.3053964       0.3085878
0.3119677       0.3153902       0.3188561       0.3222712       0.3257452
0.3296132       0.3338688       0.3383340       0.3433344       0.3490592
0.3553336       0.3622937       0.3704555       0.3794875       0.3905877
0.4036511       0.4194913       0.4371866       0.4575941       0.4774159
0.4900000
TOTAL MOISTURE CONTENT=         278.81509399 Cms.
 TOTAL MOISTURE DEFICIT=         -78.81509399 Cms.
    TIME STEP= 72
0.4900000       0.4761197       0.4456456       0.3694302       0.2868922
0.2242168       0.2125925       0.2125206       0.2130016       0.2135011
0.2140027       0.2145182       0.2151221       0.2160034       0.2168827
0.2175023       0.2181246       0.2190033       0.2198769       0.2204832
0.2210026       0.2215267       0.2221716       0.2232369       0.2246673
0.2254969       0.2260198       0.2265529       0.2272850       0.2285106
0.2297256       0.2304795       0.2311503       0.2320596       0.2331608
0.2345110       0.2358580       0.2369785       0.2380027       0.2390066
0.2400119       0.2410447       0.2421868       0.2435852       0.2451602
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0.2468437	0.2482718	0.2493348	0.2502179	0.2513370
0.2527366	0.2539814	0.2552305	0.2568677	0.2589383
0.2602861	0.2612674	0.2624828	0.2641531	0.2660655
0.2680570	0.2700809	0.2720996	0.2739232	0.2753143
0.2767028	0.2782834	0.2800386	0.2818091	0.2835623
0.2854649	0.2877559	0.2903734	0.2929751	0.2954799
0.2978098	0.3000929	0.3025628	0.3053665	0.3083593
0.3117309	0.3151968	0.3186147	0.3220749	0.3256513
0.3294977	0.3337478	0.3383461	0.3434355	0.3491234
0.3553900	0.3623739	0.3705541	0.3795906	0.3906282
0.4033486	0.4183840	0.4351964	0.4553557	0.4762463
0.4900000				

TOTAL MOISTURE CONTENT= 280.13452148 Cms.
TOTAL MOISTURE DEFICIT= -80.13452148 Cms.
TIME STEP= 96

0.4900000	0.4789947	0.4566716	0.4048227	0.3265335
0.2543903	0.2166978	0.2127187	0.2130099	0.2135020
0.2140049	0.2145285	0.2151502	0.2160044	0.2168580
0.2175033	0.2181511	0.2190036	0.2198499	0.2204734
0.2210041	0.2215428	0.2222207	0.2232780	0.2246047
0.2254602	0.2260211	0.2265802	0.2273457	0.2285129
0.2296723	0.2304691	0.2311821	0.2320896	0.2331968
0.2345144	0.2358312	0.2369662	0.2380015	0.2390091
0.2400193	0.2410669	0.2422314	0.2436218	0.2451835
0.2468100	0.2482153	0.2493084	0.2502609	0.2513885
0.2527205	0.2539914	0.2553099	0.2569467	0.2588196
0.2602169	0.2613169	0.2625838	0.2642204	0.2661001
0.2680792	0.2700900	0.2720622	0.2738372	0.2753163
0.2767585	0.2783396	0.2800582	0.2818126	0.2836126
0.2855887	0.2878860	0.2903923	0.2928661	0.2953459
0.2977431	0.3001045	0.3025950	0.3053185	0.3081922
0.3115016	0.3149808	0.3184003	0.3218932	0.3255205
0.3293880	0.3336689	0.3383396	0.3434877	0.3491893
0.3554564	0.3624471	0.3706295	0.3796242	0.3905089
0.4029052	0.4173897	0.4338248	0.4538855	0.4754068
0.4900000				

TOTAL MOISTURE CONTENT= 281.31146240 Cms.
TOTAL MOISTURE DEFICIT= -81.31146240 Cms.
TIME STEP=120

0.4900000	0.4810391	0.4642283	0.4281035	0.3572386
0.2889900	0.2303801	0.2138898	0.2130699	0.2135055
0.2140079	0.2145396	0.2151740	0.2160055	0.2168384
0.2175044	0.2181724	0.2190040	0.2198274	0.2204634
0.2210060	0.2215607	0.2222650	0.2233093	0.2245555
0.2254256	0.2260211	0.2266076	0.2273957	0.2285154
0.2296308	0.2304591	0.2312084	0.2321199	0.2332279
0.2345160	0.2358099	0.2369537	0.2379992	0.2390117
0.2400282	0.2410899	0.2422718	0.2436565	0.2452003
0.2467513	0.2481680	0.2492883	0.2502938	0.2514278
0.2527193	0.2540092	0.2553753	0.2569938	0.2587421
0.2601637	0.2613543	0.2626682	0.2642862	0.2661381
0.2681010	0.2700919	0.2720263	0.2737793	0.2753133
0.2768012	0.2783606	0.2800829	0.2818319	0.2836693
0.2856946	0.2879836	0.2904042	0.2927587	0.2952410
0.2976803	0.3000948	0.3025935	0.3052624	0.3080510
0.3112954	0.3147683	0.3181983	0.3217165	0.3253814
0.3292806	0.3336006	0.3383251	0.3435194	0.3492450
0.3555193	0.3625076	0.3706691	0.3795889	0.3903067
0.4024574	0.4165673	0.4328223	0.4528076	0.4747456
0.4900000				

TOTAL MOISTURE CONTENT= 282.39440918 Cms.
TOTAL MOISTURE DEFICIT= -82.39440918 Cms.
TIME STEP=144

0.4900000	0.4824353	0.4692612	0.4422404	0.3833886
0.3181014	0.2545068	0.2184464	0.2133753	0.2135231
0.2140122	0.2145510	0.2151943	0.2160069	0.2168230
0.2175055	0.2181896	0.2190040	0.2198086	0.2204535
0.2210083	0.2215795	0.2223048	0.2233336	0.2245164
0.2253939	0.2260207	0.2266342	0.2274377	0.2285182
0.2295983	0.2304502	0.2312308	0.2321493	0.2332554
0.2345219	0.2357930	0.2369418	0.2379963	0.2390146
0.2400385	0.2411132	0.2423089	0.2436887	0.2452130
0.2467566	0.2481284	0.2492726	0.2503190	0.2514597
0.2527279	0.2540317	0.2554283	0.2570230	0.2586899
0.2601245	0.2613842	0.2627393	0.2643490	0.2661780
0.2681213	0.2700904	0.2719949	0.2737383	0.2753099
0.2768342	0.2784270	0.2801120	0.2818621	0.2837288
0.2857857	0.2880596	0.2904129	0.2927312	0.2951574
0.2976213	0.3000697	0.3025706	0.3052002	0.3079228
0.3111067	0.3145662	0.3180053	0.3215442	0.3252418
0.3291744	0.3335341	0.3383048	0.3435391	0.3492895
0.3555710	0.3625490	0.3706737	0.3795065	0.3900722
0.4020459	0.4158893	0.4320519	0.4520255	0.4743602
0.4900000				

TOTAL MOISTURE CONTENT= 283.40313721 Cms.
TOTAL MOISTURE DEFICIT= -83.40313721 Cms.
TIME STEP=168

0.4900000	0.4834549	0.4726633	0.4517926	0.4062249
0.3419778	0.2809890	0.2296409	0.2145631	0.2136008
0.2140207	0.2145626	0.2152120	0.2160085	0.2168109
0.2175063	0.2182034	0.2190038	0.2197926	0.2204440
0.2210112	0.2215984	0.2223405	0.2233528	0.2244847
0.2253653	0.2260199	0.2266592	0.2274733	0.2285213
0.2295729	0.2304426	0.2312504	0.2321772	0.2332800
0.2345260	0.2357796	0.2369306	0.2379931	0.2390181
0.2400495	0.2411368	0.2423432	0.2437184	0.2452229
0.2467353	0.2480955	0.2492597	0.2503385	0.2514865
0.2527421	0.2540568	0.2554713	0.2570428	0.2586543
0.2600967	0.2614096	0.2628007	0.2644080	0.2662173
0.2681410	0.2700872	0.2719683	0.2737074	0.2753070
0.2768609	0.2784628	0.2801439	0.2818992	0.2837879
0.2858648	0.2881205	0.2904199	0.2926872	0.2950895
0.2975655	0.3000341	0.3025337	0.3051336	0.3078018
0.3109316	0.3143749	0.3178203	0.3213766	0.3251036
0.3290689	0.3334666	0.3382793	0.3435494	0.3493224
0.3556083	0.3625698	0.3706495	0.3793960	0.3898320
0.4016801	0.4153325	0.4314591	0.4514580	0.4740976
0.4900000				

TOTAL MOISTURE CONTENT= 284.36547852 Cms.
TOTAL MOISTURE DEFICIT= -84.36547852 Cms.
TIME STEP=192

0.4900000	0.4842663	0.4752292	0.4584764	0.4239416
0.3637064	0.3050203	0.2479752	0.2180984	0.2138848
0.2140438	0.2145749	0.2152276	0.2160103	0.2168014
0.2175071	0.2182145	0.2190035	0.2197790	0.2204354
0.2210145	0.2216174	0.2223727	0.2233683	0.2244588
0.2253398	0.2260189	0.2266821	0.2275038	0.2285248
0.2295532	0.2304364	0.2312677	0.2322034	0.2333024
0.2345306	0.2357686	0.2369203	0.2379899	0.2390217
0.2400613	0.2411600	0.2423750	0.2437456	0.2452311

0.2467171	0.2480677	0.2492492	0.2503544	0.2515101
0.2527598	0.2540825	0.2555068	0.2570572	0.2586299
0.2600780	0.2614322	0.2628542	0.2644629	0.2662564
0.2681597	0.2700842	0.2719464	0.2736839	0.2753046
0.2768827	0.2784953	0.2801778	0.2819404	0.2838463
0.2859341	0.2831710	0.2904263	0.2926526	0.2950327
0.2975125	0.2999917	0.3024870	0.3050635	0.3076856
0.3107667	0.3141940	0.3176431	0.3212136	0.3249678
0.3289640	0.3333974	0.3382487	0.3435510	0.3493434
0.3556304	0.3625717	0.3706041	0.3792709	0.3896003
0.4013606	0.4148735	0.4309951	0.4510245	0.4739017
0.4900000				

TOTAL MOISTURE CONTENT= 285.29281616 Cms.

TOTAL MOISTURE DEFICIT= -85.29281616 Cms.

TIME STEP=216

0.4900000	0.4849479	0.4772940	0.4635355	0.4365704
0.3833596	0.3264236	0.2694931	0.2261412	0.2147714
0.2141149	0.2145904	0.2152416	0.2160124	0.2167941
0.2175079	0.2182234	0.2190029	0.2197673	0.2204279
0.2210182	0.2216359	0.2224015	0.2233809	0.2244373
0.2253173	0.2260178	0.2267028	0.2275302	0.2285286
0.2295378	0.2304316	0.2312831	0.2322278	0.2333229
0.2345354	0.2357598	0.2369110	0.2379866	0.2390256
0.2400735	0.2411828	0.2424050	0.2437703	0.2452379
0.2467016	0.2480446	0.2492403	0.2503673	0.2515316
0.2527797	0.2541083	0.2555371	0.2570684	0.2586139
0.2600665	0.2614535	0.2629023	0.2645139	0.2662940
0.2681775	0.2700820	0.2719288	0.2736659	0.2753038
0.2769020	0.2785256	0.2802131	0.2819844	0.2839027
0.2859957	0.2882133	0.2904322	0.2926246	0.2949837
0.2974617	0.2999446	0.3024342	0.3049909	0.3075727
0.3106100	0.3140222	0.3174735	0.3210561	0.3248339
0.3288603	0.3333263	0.3382130	0.3435440	0.3493527
0.3556382	0.3625576	0.3705438	0.3791401	0.3893824
0.4010801	0.4144818	0.4306328	0.4506869	0.4737502
0.4900000				

TOTAL MOISTURE CONTENT= 286.18634033 Cms.

TOTAL MOISTURE DEFICIT= -86.18634033 Cms.

TIME STEP=240

0.4900000	0.4855181	0.4789549	0.4673421	0.4457355
0.4017715	0.3448954	0.2905453	0.2393999	0.2171147
0.2143255	0.2146165	0.2152551	0.2160148	0.2167885
0.2175087	0.2182305	0.2190022	0.2197572	0.2204212
0.2210223	0.2216541	0.2224273	0.2233917	0.2244195
0.2252976	0.2260172	0.2267216	0.2275532	0.2285328
0.2295261	0.2304281	0.2312972	0.2322504	0.2333418
0.2345403	0.2357528	0.2369027	0.2379836	0.2390296
0.2400860	0.2412049	0.2424331	0.2437931	0.2452441
0.2466883	0.2480251	0.2492328	0.2503780	0.2515517
0.2528006	0.2541336	0.2555633	0.2570781	0.2586034
0.2600606	0.2614737	0.2629454	0.2645611	0.2663300
0.2681954	0.2700807	0.2719144	0.2736520	0.2753039
0.2769192	0.2785546	0.2802486	0.2820289	0.2839567
0.2860512	0.2882502	0.2904376	0.2926014	0.2949412
0.2974128	0.2998945	0.3023769	0.3049143	0.3074647
0.3104604	0.3138583	0.3173108	0.3209031	0.3247022
0.3287574	0.3332532	0.3381721	0.3435288	0.3493508
0.3556333	0.3625306	0.3704737	0.3790086	0.3891793
0.4008331	0.4141490	0.4303391	0.4504182	0.4736308
0.4900000				