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Development of a Mathematical Model for Estimating Infiltration Rate on Sandy Loam Soil

Hassan Saje[1], J.M Dibal [2], Ahmed Bunu[3], Kachalla D. Maina[4]

Department of Agricultural Engineering Technology, Ramat Polytechnic Maiduguri, [1&4] Department of Agricultural and Environmental Engineering. University of Maiduguri [2]Department of Agricultural Technology, Ramat Polytechnic Maiduguri[3]

Abstract: *This study developed a mathematical model for estimating infiltration rate of a sandy-loam soil at the University of Maiduguri for the study area. Laboratory experiment on variation of Infiltration rate with some factors that influence infiltration (Dry bulk density, Water head, Texture, Soil depth, Organic matter and Antecedent moisture content).rate was conducted, at 5 levels, and each replicated 3 times. A total of 30 treatments in a factorial design was used All the six (6) functional parameters (input variables) considered in the decision process in search of optimal solution were subjected to dimensional analysis (Buckingham's pi theorem) and multiple regressions using Cramer's rule, which led to the development of a composite infiltration model. SAS package was used for the statistical analysis of variance .The indices of model evaluation used were coefficient of determination, bias, root mean square error, index of agreement, slope and intercept of plots between the predicted values obtained from the developed models and the measured values obtained from field experiments. Differential sensitivity coefficients were used to rank variables according to their order of importance in the developed models. Results of the sensitivity analysis revealed that infiltration rate is most sensitive to changes in soil depth which has the highest sensitivity coefficient values of 2.29,105.99 and least affected by the antecedent moisture content with sensitivity coefficient of0.00, 0.00, for both the predicted and observed infiltration rates respectively . This model for infiltration could easily be incorporated into field analysis to help provide improved predictions of infiltration in the study area.*

Key words: *Infiltration Rate, Mathematical Model and Soil*

1.0 INTRODUCTION

The ability to quantify infiltration is of great importance in watershed management. Prediction of flooding, erosion and pollutant transport all depend on the rate of runoff which is directly affected by the rate of infiltration. Quantification of infiltration is also necessary to determine the availability of water for crop growth and to estimate the amount of additional water needed for irrigation. Also, by understanding how infiltration rates are affected by surface conditions, measures can be taken to increase infiltration rates and reduce the erosion and flooding caused by overland flow. The use of mathematical models and computer simulations in engineering, hydrology, and various fields in the process of decision making is progressively gaining more acceptances (Foltz *et al*,2011). Models are useful tools for representing the detailed and complex "real world" with a more simple and understandable structure and can be used in demonstrating the relationships and interactions amongst various factors (Bjorneberg *et al*,2000). Furthermore, models allow the decision-maker to combine information from various sources and, in some cases, to extrapolate findings beyond the trial period (Foltz *et al*,2011). They can also be employed in the identification of promising technologies and reduce the time and expense of field experiments by focusing resources on these most promising technologies (Skonard and Martin ,2000). In order to develop improved hydrologic models, accurate methods for characterizing infiltration are required (Shirmohammadi and Skaggs,1984).

In Maiduguri and environs, hydrological problems such as flooding, erosion, pollution and soil management problems have been militating against many socio-economic efforts of farmers. Current knowledge of infiltration processes into soils has not been adequate to address such problems. Research work toward minimizing such problems would be very essential. Models are very essential tools for predicting and solving several hydrological challenges, however, not all models are applicable everywhere due to either being site specific, or non-transferability of their coefficients and/or indices. In view of this, there is the need to develop a composite model that incorporate all the major soil factors that influence infiltration rate which can be applied in the infiltration rate measurement at any time, given the values of the soil physical properties for the study area.

The aim of the study is to develop a composite mathematical model for estimating infiltration rate using multiple soil parameters of Water Head , Dry bulk density, Soil Texture, Soil Depth, Antecedent moisture content and Organic matter content, to assess the sensitivity of the model to the various input parameters.The study involves only intrinsic soil factors that affect soil infiltration rate. Other factors that are not soil dependent and cannot be experimented using laboratory approach are not considered in this research. Only laboratory approach is being employed throughout, hence disturbed soil samples were used to enable modification of the soil physical properties such as texture, density, moisture content, soil depth, and organic matter content.

2.0 MATERIALS AND METHODS

The study was carried out in the Department of Agricultural and Environmental Resources Engineering laboratory, University of Maiduguri. Maiduguri is the capital of Borno State. It lies between latitudes 11^{o} 45\`N and 11$^{o}$ 51\`N, Longitudes 13^{o} 2\`E and 13$^{o}$ 9\`E and 345m above mean sea level with a mean annual rainfall of about 625mm and annual temperature of 28-32^{o}C Adeniji *et al*,(2013).

2.1 *SAMPLE COLLECTION AND PREPARATION*

The soil samples were collected using soil auger, at depths of 0–30cm from the soil surface of undisturbed land, at five points spaced at 35-50m apart and then bulked together to form composite samples. The bulk soil samples was air dried, all clumps and aggregates broken and then, subjected to particle size analysis(P.S.A) using dry sieving method as described by ASTM (2006) Standard test method for particle size analysis. The samples were then divided into sacks according to each treatment weighing 25 kg.

2.2 *TREATMENTS AND EXPERIMENTAL DESIGN*

The experimental factors studied as they influence infiltration rate were the intrinsic soil factors of dry bulk density, water head, soil texture, soil depth, organic matter content and antecedent moisture content, each at five treatments, respectively. Ninety (90) experiments using factorial design was carried out constituting a total of 6 experimental factors and 30 treatments, each replicated three times as follows:

Table 2.1 Experimental Treatments

Experimental factors	Experimental treatments/replications
Water head(cm)	(H_{20-1},H_{16-1},H_{12-1},H_{8-1},H_{4-1})(H_{20-2},H_{16-2},H_{12-2},H_{8-2},H_{4-2}) (,H_{20-3},H_{16-3},H_{12-3},H_{8-3},H_{4-3})
Soil depth (cm)	(D_{25-1},D_{22-1},D_{19-1},D_{16-1},D_{13-1})(D_{25-2},D_{22-2},D_{19-2}, D_{16-2},D_{13-2})(D_{25-3},D_{22-3},D_{19-3},D_{16-3},D_{13-3})
Soil texture	($F_{80/20-1}$,$F_{60/40-1}$,$F_{50/50-1}$,$F_{40/60-1}$,$F_{20/80-1}$)($F_{80/20-2}$,$F_{60/40-2}$, $F_{50/50-2}$,$F_{40/60-2}$,$F_{20/80-2}$)($F_{80/20-3}$,$F_{60/40-3}$,$F_{50/50-3}$,$F_{40/60-3}$,$F_{20/80-3}$)
Ant. Moisture content	(%)(Θ_{20-1},Θ_{40-1},Θ_{60-1},Θ_{80-1},Θ_{100-1})(Θ_{20-2},Θ_{40-2},Θ_{60-2},Θ_{80-2},Θ_{100-2}) (Θ_{20-3},Θ_{40-3},Θ_{60-3},Θ_{80-3},Θ_{100-3})
Soil bulk density(g/cm³)	($\rho_{1.85-1}$, $\rho_{1.71-1}$, $\rho_{1.67-1}$,$\rho_{1.53-1}$, $\rho_{1.46-1}$)($\rho_{1.85-2}$, $\rho_{1.71-2}$, $\rho_{1.67-2}$,$\rho_{1.53-2}$, $\rho_{1.46-2}$) ($\rho_{1.85-3}$, $\rho_{1.71-3}$, $\rho_{1.67-3}$,$\rho_{1.53-3}$, $\rho_{1.46-3}$)
Organic matter content	O_{12-1}, O_{14-1}, O_{16-1},O_{18-1}, O_{20-1})(O_{12-2}, O_{14-2}, O_{16-2},O_{18-2}, O_{20-2}) (O_{12-3}, O_{14-3}, O_{16-3},O_{18-3}, O_{20-3})

Where;

H = Water head, D = Soil depth, F = Soil Texture, Θ = Antecedent moisture content, ρ = Soil dry bulk density, O = Soil organic matter content

2.3 *VARIATION OF INFILTRATION RATES*

Infiltration test was carried out, using individual factors, each experiment constituted five trials of T1- T5 (variation of values) after preparing the soil samples in order of the required percentages by mass as follows:

Experiment 1: Variation of infiltration rate with Water Head (H) at 20, 16, 12, 8 and 4cm, respectively.

Experiment 2: Variation of infiltration rate with soil depth. Where D_1, D_2, D_3, D_4 and D_5 are the variations in values of depths of soil at 25, 22, 19, 16 and 13cm, respectively.

Experiment 3: Variation of infiltration rate with coarse to fine fraction (sand/silt clay) at ratio of 80/20, 60/40, 50/50, 40/60 and 20/80, respectively.

Experiment 4: Variation of infiltration rate with antecedent moisture content (ϴ) at 20, 40, 60, 80 and 100 %, respectively.

Experiment 5: Variation of infiltration rate with dry bulk density (ρ) at 1.85, 1.71, 1.67, 1.53 and 1.46 g/cm^3, respectively.

Experiment 6: Variation of infiltration rate with organic matter content (%) at 12, 14, 16,19 and 20 percent, respectively.

2.4 *COMPOSITE MODEL DEVELOPMENT*

The Composite Infiltration model was developed using dimensional analysis following the concept of Buckingham π-theorem and multiple regression analysis.

2.4.1 *ASSUMPTIONS*

In developing the model, the following assumptions were made:

Soil in the test plots was assumed to be of homogenous type.

1. Infiltration rate varies linearly with water head,
2. Infiltration rate varies linearly with soil depth,
3. Infiltration rate varies linearly with soil bulk density,
4. Infiltration rate varies linearly with soil texture,
5. Infiltration rate varies linearly with antecedent moisture content,
6. Infiltration rate varies linearly with organic matter content,

2.5 *PREDICTION EQUATION FOR COMPOSITE INFILTRATION RATE*

The applications of dimensional analysis, including the Pi theorem led to the formation of Equation 2.1.

$$IDF\Theta O\sqrt{\frac{H}{g}} = \phi\left[, DHF\Theta\,,\ \sqrt{\frac{g}{H}}T\right] \qquad \textbf{(2.1)}$$

3.0 RESULTS AND DISCUSSION

Equation 3.1 is the required composite model developed, which was used to determine infiltration rate at any time, given the values of the factors considered. The parameters in the equation can be easily obtained from field test and is in agreement with Mezencev(1948).

$$I = \frac{1521.71}{DF\theta O}\sqrt{\frac{g}{H}} + \frac{11.38\sqrt{Hg}}{O} - \frac{5.06gT}{DF\theta O\sqrt{H}} \quad \textbf{(3.1)}$$

Table 3.1: Infiltration Rate vs. time (cm/hr.) obtained for different water heads (20, 16, 12, 8, and 4) cm respectively.

Sample Number	Water Heads (cm)	INFILTRATION RATE AND TIME OBTAINED											
1	20	F (cm/hr.)	116.22	102.3	91.2	52.7	37.63	24.35	21.73	12.93	10.51	7.62	6.25
		T (hrs.)	0.042	0.085	0.129	0.173	0.227	0.281	0.341	0.403	0.47	0.539	0.614
2	16	F (cm/hr.)	112.02	83.45	65.86	31.16	26.23	23.37	21.141	12.34	10.147	9.14	8.66
		T (hrs.)	0.043	0.09	0.138	0.189	0.243	0.298	0.36	0.409	0.422	0.45	0.55
3	12	F (cm/hr.)	102.01	76.16	56.81	30.69	25.24	22.82	19.37	12.11	11.76	9.451	9.21
		T (hrs.)	0.037	0.08	0.118	0.162	0.204	0.253	0.294	0.346	0.393	0.45	0.47
4	8	F (cm/hr.)	97.36	72.56	50.42	28.41	25.01	20.36	20.15	11.193	10.65	9.97	8.96
		T (hrs.)	0.035	0.072	0.11	0.153	0.195	0.239	0.283	0.325	0.375	0.417	0.542
5	4	F (cm/hr.)	87.67	67.13	44.82	24.51	24.39	23.31	17.27	15.74	13.085	11.65	11.43
		T(hrs.)	0.03	0.075	0.098	0.135	0.171	0.208	0.246	0.287	0.331	0.370	0.412

Table 3.2: Infiltration Rate vs. time (cm/hr) obtained for different soil depths (8.5, 10, 13, 15, and 17) cm respectively.

Sample Number	Soil Depth(cm)	INFILTRATION RATE AND TIME OBTAINED											
1	25	F (cm/hr.)	106.22	92.3	33.2	24.6	16.63	15.35	10.73	9.53	8.41	7.72	6.15
		T (hrs.)	0.042	0.085	0.129	0.173	0.227	0.281	0.341	0.403	0.47	0.539	0.614
2	22	F (cm/hr.)	90.07	53.38	25.90	22.16	20.24	14.43	10.41	9.66	8.47	7.84	7.45
		T (hrs.)	0.043	0.09	0.138	0.189	0.243	0.298	0.36	0.409	0.422	0.45	0.55
3	19	F (cm/hr.)	89.22	51.06	24.88	20.91	18.35	13.82	10.08	9.60	8.17	7.45	7.23
		T (hrs.)	0.037	0.08	0.118	0.162	0.204	0.253	0.294	0.346	0.393	0.45	0.47
4	16	F (cm/hr.)	88.83	50.56	23.14	20.14	18.01	12.35	10.05	9.19	8.06	7.38	7.21
		T (hrs.)	0.035	0.072	0.11	0.153	0.195	0.239	0.283	0.325	0.375	0.417	0.542
5	13	F (cm/hr.)	87.95	49.43	20.81	20.04	17.92	12.23	9.27	9.086	8.01	7.33	7.17
		T (hrs.)	0.03	0.075	0.098	0.135	0.171	0.208	0.246	0.287	0.331	0.370	0.412

Table 3.3Infiltration Rate vs. time (cm/hr) obtained for different fine to coarse fraction F (10%-90%, 40%-60%, 70% - 30%, 30%-70%, 10%-90%) m respectively

Sample Number	Coarse to Fine fraction (F)	INFILTRATION RATE AND TIME OBTAINED											
1	80%/20%	F (cm/hr.)	70.18	68.97	59.70	57.97	47.62	47.06	43.75	40.08	39.22	39.12	39.04
		T (hrs.)	0.042	0.085	0.129	0.173	0.227	0.281	0.341	0.403	0.47	0.539	0.614
2	60%/40%	F (cm/hr.)	53.33	52.62	47.62	46.51	45.43	45.11	44.44	43.01	38.46	37.38	36.37
		T (hrs.)	0.043	0.09	0.138	0.189	0.243	0.298	0.36	0.409	0.422	0.45	0.55
3	50%/50%	F (cm/hr.)	49.51	44.94	44.45	40.58	38.65	37.36	36.89	32.68	32.44	30.23	29.79
		T (hrs.)	0.037	0.08	0.118	0.162	0.204	0.253	0.294	0.346	0.393	0.45	0.47
4	40%/60%	F (cm/hr.)	47.94	44.28	42.53	39.12	37.66	37.05	35.43	31.93	31.52	29.33	27.46
		T (hrs.)	0.035	0.072	0.11	0.153	0.195	0.239	0.283	0.325	0.375	0.417	0.542
5	20%/80%	F (cm/hr.)	47.64	43.34	40.07	32.36	32.18	30.44	29.60	28.17	28.05	27.41	26.92
		T (hrs.)	0.03	0.075	0.098	0.135	0.171	0.208	0.246	0.287	0.331	0.370	0.412

Table 3.4: Infiltration Rate vs. time (cm/hr) obtained for different antecedent moisture content ϴ (100, 80, 60, 40, and 20) % respectively.

Sample Number	antecedent moisture content (ϴ)	INFILTRATION RATE AND TIME OBTAINED											
1	100	F (cm/hr.)	66.67	48.20	43.96	44.44	38.46	37.74	32.52	32.52	29.18	23.12	21.74
		T (hrs.)	0.042	0.085	0.129	0.173	0.227	0.281	0.341	0.403	0.47	0.539	0.614
2	80	F (cm/hr.)	67.97	54.45	49.22	46.70	36.54	36.36	33.34	33.31	31.75	29.21	28.78
		T (hrs.)	0.043	0.09	0.138	0.189	0.243	0.298	0.36	0.409	0.422	0.45	0.55
3	60	F (cm/hr.)	77.14	69.34	53.33	47.62	44.44	43.01	39.22	39.01	37.74	32.26	32.08
		T (hrs.)	0.037	0.08	0.118	0.162	0.204	0.253	0.294	0.346	0.393	0.45	0.47
4	40	F (cm/hr.)	71.43	68.97	67.92	66.67	58.82	58.82	54.14	53.79	47.06	43.96	36.79
		T (hrs.)	0.035	0.072	0.11	0.153	0.195	0.239	0.283	0.325	0.375	0.417	0.542
5	20	F (cm/hr.)	96.33	76.45	71.23	69.62	61.43	60.56	58.47	56.64	51.55	46.44	40.32
		T (hrs.)	0.03	0.075	0.098	0.135	0.171	0.208	0.246	0.287	0.331	0.370	0.412

Table 3.5: Infiltration Rate vs. time (cm/hr.) obtained for different bulk densities ρ (kg/cm3) at 20, 16,12,8 and 4 blows respectively.

Sample Number	Bulk density(g/cm^3)	INFILTRATION RATE AND TIME OBTAINED											
1	1.85	F (cm/hr.)	53.33	45.46	43.96	43.01	8.09	7.03	3.61	2.79	1.75	1.72	1.69
		T (hrs.)	0.042	0.085	0.129	0.173	0.227	0.281	0.341	0.403	0.47	0.539	0.614
2	1.71	F (cm/hr.)	70.38	57.97	53.33	47.06	46.51	45.45	44.94	43.48	43.48	43.01	39.22
		T (hrs.)	0.043	0.09	0.138	0.189	0.243	0.298	0.36	0.409	0.422	0.45	0.55
3	1.67	F (cm/hr.)	75.43	62.37	59.43	57.45	51.76	48.52	47.37	47.06	45.75	45.12	40.23
		T (hrs.)	0.037	0.08	0.118	0.162	0.204	0.253	0.294	0.346	0.393	0.45	0.47
4	1.53	F (cm/hr.)	91.44	82.66	67.91	62.33	60.13	55.48	51.39	49.78	47.42	47.18	44,32
		T (hrs.)	0.035	0.072	0.11	0.153	0.195	0.239	0.283	0.325	0.375	0.417	0.542
5	1.46	F (cm/hr.)	101.24	93.43	89.17	71.91	70.43	67.18	65.46	51.22	48.53	47.87	46.08
		T (hrs.)	0.03	0.075	0.098	0.135	0.171	0.208	0.246	0.287	0.331	0.370	0.412

Table 3.6: Infiltration Rate vs. time (cm/hr.) obtained for different organic matter content O (%) at 0.20,0 .18, 0.16, 0.14 and 0.12 percent respectively

Sample Number	Organic matter content (%)	INFILTRATION RATE AND TIME OBTAINED											
1	0.12	F (cm/hr.)	96.22	52.3	31.2	22.7	17.63	14.35	11.73	9.93	8.51	7.62	5.14
		T (hrs.)	0.042	0.085	0.129	0.173	0.227	0.281	0.341	0.403	0.47	0.539	0.614
2	0.14	F (cm/hr.)	98.02	43.45	28.99	21.164	16.2	13.377	11.141	9.46	8.147	7.14	5.68
		T (hrs.)	0.043	0.09	0.138	0.189	0.243	0.298	0.36	0.409	0.422	0.45	0.55
3	0.16	F (cm/hr.)	112.21	54.06	33.88	24.691	19.24	15.82	13.38	11.561	10.176	7.451	7.22
		T (hrs.)	0.037	0.08	0.118	0.162	0.204	0.253	0.294	0.346	0.393	0.45	0.47
4	0.18	F (cm/hr.)	115.3	55.56	36.4	26.144	20.41	16.736	14.135	12.195	10.69	9.547	8.521
		T (hrs.)	0.035	0.072	0.11	0.153	0.195	0.239	0.283	0.325	0.375	0.417	0.542
5	0.20	F (cm/hr.)	137.92	63.43	40.82	29.851	23.392	19.231	16.27	13.886	12.085	10.695	10.331
		T (hrs.)	0.03	0.075	0.098	0.135	0.171	0.208	0.246	0.287	0.331	0.370	0.412

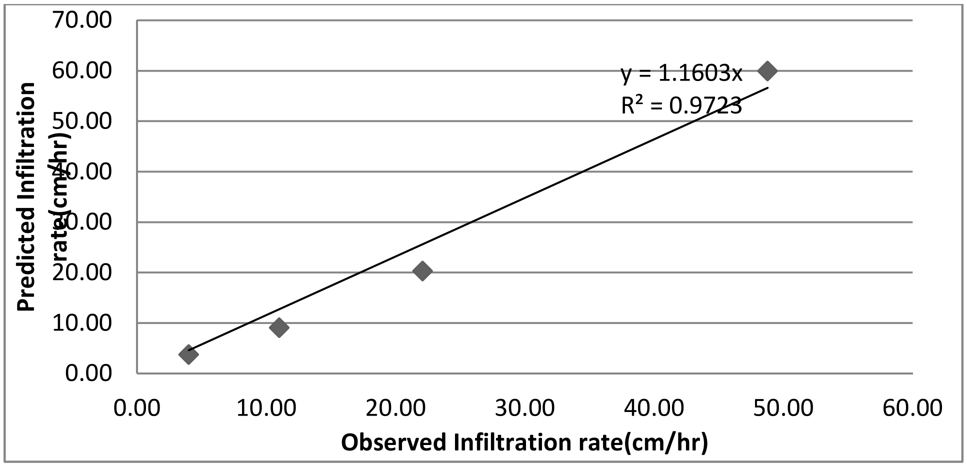

Figure 3.1: Plot of Predicted against Observed values of infiltration rates

The model output and the experimental result plotted on the graph yielded the slope and intercept of 1.160 and 0.00 respectively and R^2 of 0.972 exhibited a high degree of agreement between the model output and the field observed data. Hence, the null hypothesis is upheld that the slope is not statistically different from 1.0 and the intercept is equal to zero at 5% level, using the Duncan's multiple range test (DMRT). This showed that there is a very high agreement between the predicted and observed infiltration rate, which implies that the developed model is a good representation of real infiltration rate on a sandy loam soil in the study area.

3.1 *SENSITIVITY ANALYSIS*

The sensitivity analysis of the model (Eqn. 3.1) was performed following the procedure delineated by Hamby, (1994). Computed sensitivity values are shown in Tables 4.24 and 4.25 from the absolute value (It is irrespective of the sign, the sign signifies the direction because of the derivative) for the observed and predicted infiltrations, respectively. It could be seen that the sensitivity coefficients of the independent variables ranged between 105.99 to - 1.44 for the observed infiltration rates and 2.29 to -0.19 for the predicted infiltration rates respectively. Sensitivity coefficients of the observed infiltration rates are; Water head (0.00), soil depth (2.29), bulk density (-0.19), antecedent moisture content (0. 00), Soil texture (2.15 and organic matter content (0.00). Sensitivity coefficients of the predicted infiltration are; Water head (0.00), soil depth (105.99), bulk density (-1.44), antecedent moisture content (0. 00), Soil texture (83.31) and organic matter content (0.00). Results of the sensitivity analysis revealed that the model is most sensitive to changes in soil depth has the dominantly highest sensitivity coefficient and least affected by the antecedent moisture content, for both the predicted and observed infiltration rates probably because basic infiltration is attained only when the soil is fully saturated . This has built confidence in the model by studying the uncertainties that are often associated with parameters in models, which is in line with Breierova and Choudhari, (2001).

Table 4 Sensitivity coefficients

	Observed infiltration		Predicted infiltration	
Independent Variables	*Coefficients*	*Standard Error*	*Coefficients*	*Standard Error*
Intercept	18.16	3.72	2.80	5.82
Sample	0.00	0.00	0.00	0.00
Water Heads	0.00	0.00	0.00	0.00
Soil Depth	2.29	2.14	105.99	3.35
Soil bulk density	-0.19	0.10	-1.44	0.16
Ant/ moisture content (ϴ)	0.00	0.00	0.00	0.00
Soil Texture	2.15	1.22	83.31	2.54
organic matter content (%)	O0.00	0.00	0.00	0.00

Table5 T-test

Predicted Infiltration Rate (cm/hr.)	Observed Infiltration Rate (cm/hr.)	*T-test*	*Predicted values*	*Observed values*
598.27	283.00	Mean	138.27	73.77
59.91	48.78	Variance	66607.48	13970.05
20.29	22.08	Observations	5.00	5.00
9.11	11.01	Pooled Variance	40288.77	
3.78	4.00	Hypothesized Mean Difference	0.00	
		D.f	8.00	
		t Stat	0.51	
		P(T<=t) one-tail	0.31	
		t Critical one-tail	1.86	
		P(T<=t) two-tail	0.63	
		t Critical two-tail	2.31	

From Table 5, it can be seen that T Stat < T critical. This implies that there is no significant difference between the measured and predicted values. Therefore, the developed model and the field infiltration measurement produce the same result.

Table 6 Goodness of fit (F-test)

Predicted Infiltration Rate (cm/hr)	Observed Infiltration Rate (cm/hr)	Regression Statistics	
598.27	283.00	Multiple R	0.995198
59.91	48.78	R Square	0.990419
20.29	22.08	Adjusted R Square	-2.03833
9.11	11.01	Standard Error	0.287234
3.78	4.00	Observations	5

There is 99% relationship between the independent variables and the infiltration rate as predicted by R Square multiple regression analysis.

CONCLUSION

The model for predicting soil Infiltration rate on a sandy loam soil developed in this study was tested and found capable of simulating Infiltration rate close to measured data. The developed model exhibited a high degree of agreement between the model output and the observed field data. The result of model validation indicate RMSE, Bias, d and SB values of 4.54, 0.73, 0.77 and 0.09, respectively, which shows that there exist but a little deviation between the predicted and measured infiltration rates. The degree of accuracy of the developed model was simulated against a different set of field infiltration test data .The model output and the experimental result plotted on the graph yielded the slope and intercept of 0.8506 and 0.00 respectively and R^2 of 0.9662 exhibited a high degree of agreement between the model output and the field observed data , which implies that the developed model is a good representation of real infiltration rate on a sandy loam soil in the study area. The sensitivity analysis of the independent variables performed yielded the sensitivity coefficients of the observed infiltration rates for Water head 0.00, soil depth 2.29, bulk density -0.19, antecedent moisture content 0. 00, organic matter content 0.00 and predicted infiltration rates for Water head 0.00, soil depth 105.99, bulk density -1.44, antecedent moisture content 0. 00, organic matter content 0.00 respectively, with soil depth having the highest sensitivity coefficient and least affected by the Antecedent moisture content. T- test results yielded T-stat 0.51 and T- critical (one-tail 0.86 , two-tail 2.31)respectively, with T Stat < T critical which implies that there is no significant difference between the measured and predicted values. Goodness of fit values give R^2 99% ,SE 0.29. which indicate a 99% relationship between the independent variables and the infiltration rate as predicted by R Square multiple regression analysis.

The model can be employed in the planning for the problems about surface runoff, flood pollution, soil erosion, irrigation and drainage planning and management for the study area. A knowledge of this research work will play major role in controlling such problems.

***R*EFERENCES**

Adeniji F.A, B.G Umara, J.M Dibal and Amali A.A (2013) Variation of infiltration rate with Soil Texture. A laboratory study.International Journal of Engineering and Innovative Technology (IJEIT) Vol.3. Issue 2.pp:454-459.

Bjorneberg D. L., Kincaid D. C., Lentz R. D., Sojka R. E., and Trout T. J. (2000) "Unique aspects of modeling irrigation-induced soil erosion," International Journal of Sediment Research, vol. 15, no. 2, pp. 245-252.

Breierova, L. and Choudhari, M. (2001).*An Introduction to SensitivityAnalysis.* The Massachusetts Institute of Technology (MIT) System Dynamics in Education Project.

pp 47 Foltz R. B., Elliot W. J., and Wagenbrenner N. S., (2011) "Soil erosion model predictions using parent material/soil texture-based parameters compared to using site-specific parameters," Transactions of the ASABE, vol. 54, no. 4, pp. 1347-1356.

Mezencev, V. J. (1948). Theory of formation of the surface runoff.*Meteorologiae Hidrologia*3:33-40.

Shirmohammadi, A. and R. W. Skaggs. (1984). Effect of soil surface conditions on infiltration for shallow water table soils. *Transactions of the ASAE*27(6): 1780-1787.