EXPERIMENTAL STUDY FOR DETERMINATION OF INFILTRATION RATE OF SOILS IN FIELD USING DOUBLE RING INFILTROMETER

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Master of Technology
In
Civil Engineering

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EXPERIMENTAL STUDY FOR DETERMINATION OF INFILTRATION RATE OF SOILS IN FIELD USING DOUBLE RING INFILTROMETER

A thesis
Submitted by

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(212CE4486)

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for the award of the degree of

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Certificate

This is to certify that the thesis entitled "**Standard Test for Determination of Infiltration Rate of Soil Using Double Ring Infiltrometer**" by **AMREETA CHAMPATIRAY (212CE4486),** inpartial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering during session 2011-2013 in the Specialization of Water Resource Engineering in Civil Engineering Department, National Institute of Technology Rourkela is an authentic work carried out by her under our supervision and guidance. To the best of our knowledge, the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any Degree or Diploma.

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Place-

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TABLE OF CONTENTS

LIST OF FIGURES:-

List of Tables:-

Abstract

Infiltration is the process of penetration of water into the ground surface and the intensity of this process is known as infiltration rate. The infiltration rate is expressed in term of volume of water poured per ground surface per unit of time. Soil erosion, surface runoff & ground water recharge are affected by this process. At a certain moment the maximum infiltration rate can be indicated by the infiltration capacity of soil. Infiltration of water into the soil can be determined by a simple instrument called Double ring infiltrometer. The cylindrical ring infiltrometer consist of single metal cylinder. These cylinders are partially inserted into the ground and water is filled up to a margin inside the cylinder and after that the speed of penetration of water is measured with respect to the time and depth of penetration of water inside the cylinder.

Four types of cylinders are taken for this experiment of diameter 15cm, 30cm, 45cm & 60cm and they are experimented as 15-45cm & 30-60cm double ring infiltrometer. To spread the water vertically after infiltration we use double ring infiltrometer. Double ring infiltrometer is better than single ring infiltrometer. In single ring infiltrometer the water will spread horizontally & vertically both, from which water will not move only towards the ground water but using double ring infiltrometer the water will penetrate in one direction that is towards the ground water without much wastage of water.

CHAPTER 1

INTRODUCTION

1.1 GENERAL

By two strengths penetration is administered i.e slim activity and gravity. In gravity, more By two strengths invasion is represented like activity and gravity. In gravity, more terrific safety is offered by littler pores, through slim activity little pores force water against the power of gravity. For that reason forested zones have the most astounding invasion rates from any vegetative types.the top layer of leaf litter that is not decayed ensures the dirt from the beating movement of drizzle; without this the dirt can get far less penetrable. In chaparral vegetated regions, the hydrophobic oils in the succulent leaves could be spread over the dirt surface with flame, making vast zones of hydrophobic soil. Different conditions that can lower penetration rates or square them incorporate dry plant litter that opposes re-wetting, or ice. In the event that dirt is immersed at the time of a compelling solidifying period, the dirt can turn into a cement ice on which practically no penetration might happen. Over a whole watershed, there are liable to be holes in the solid ice or hygroscopic soil where water can infiltrate.once water has invaded the dirt it stays in the dirt, permeates down to the ground water table, or gets to be some piece of the subsurface overflow process.

1.2 HYDROLOGY

Hydrology is the investigation of the development, conveyance, and nature of water on Earth and different planets, including the hydrologic cycle, water assets and natural watershed manageability. An

expert of hydrology is a hydrologist, working inside the fields of earth or ecological science, physical geology, geography or common and natural building.

Hydrology is subdivided into surface hydrology and marine hydrology. Areas of hydrology include hydrometeorology, surface hydrology, hydrogeology, waste bowl administration and water quality, where water assumes the focal part. Oceanography and meteorology are not included in light of the fact that water is one and only of numerous critical perspectives inside those fields.

Hydrology is the science that incorporates the event, dispersion, development and properties of the waters of the earth and their association with nature inside each one period of the hydrologic cycle. The water cycle, or hydrologic cycle, is a constant process by which water is purged by vanishing and transported from the world's surface (counting the seas) to the air and again to the area and seas. The majority of the physical, substance and organic techniques including water as it ventures its different ways in the climate, over and underneath the world's surface and through developing plants, are of enthusiasm to the individuals who study the hydrologic cycle. There are numerous pathways the water may take in its consistent cycle of falling as precipitation or snowfall and coming back to the climate. It may be caught for a large number of years in polar ice tops. It may stream to streams lastly to the ocean. It may drench into the dirt to be dissipated specifically from the dirt surface as it dries or be transpired by developing plants. It may permeate through the dirt to ground water stores (aquifers) to be put away or it may stream to wells or springs or once again to streams by drainage. They cycle for water may be short, or it may take a huge number of years. Individuals tap the water cycle for their own particular employments. Water is occupied briefly from one a piece of the cycle by pumping it from the beginning drawing it from a stream or lake. It is utilized for a mixture of exercises, for example, families, organizations and commercial enterprises; for watering system of ranches and parklands; and for creation of electric force. After utilization, water is come back to an alternate some piece of the cycle:

maybe released downstream or permitted to drench into the ground. Utilized water typically is lower within quality, significantly after medication, which regularly represents an issue for downstream clients.

1.3. RAINFALL& SURFACE RUNOFF

In our area about water stockpiling in the seas we depict how the seas demonstration as a vast storage facility of water that evaporates to get air dampness. The seas are kept full by precipitation and likewise by overflow and release from waterways and the ground. Numerous individuals likely have an excessively-disentangled thought that precipitation falls on the area, streams overland (spillover), and runs into waterways, which then vacant into the seas. That is "excessively streamlined" in light of the fact that waterways likewise addition and lose water to the ground. Still, the reality of the matter is that a great part of the water in streams comes specifically from spillover from the area surface, which is characterized as surface overflow.

Overland runoff from disturbed areas often contain excessive sediment in addition to water. (USGS)

Figure 1: Overland Runoff

At the point when drizzle hits immersed or impenetrable ground it starts to stream overland downhill. It is not difficult to check whether it streams down your carport to the control and into a storm sewer, yet it

is harder to recognize it streaming overland in a regular setting. Throughout an overwhelming drizzle you may perceive little rivulets of water streaming downhill. Water will stream along channels as it moves into bigger streams, streams, and waterways. This picture gives a realistic illustration of how surface spillover (here streaming off a way) enters a little spring. The overflow for this situation is streaming over exposed soil and is storing silt into the stream (not useful for water quality). The spillover entering this river is starting its voyage once more to the sea.

1.4 INFILTRATION & INFILTRATION RATE

Invasion is the stream of water through the dirt surface into a permeable medium under gravity activity and weight impacts.

1.4.1.Infiltration characteristics

The invasion limit is the greatest rate at which water might be retained by a given soil for every unit range under given conditions.

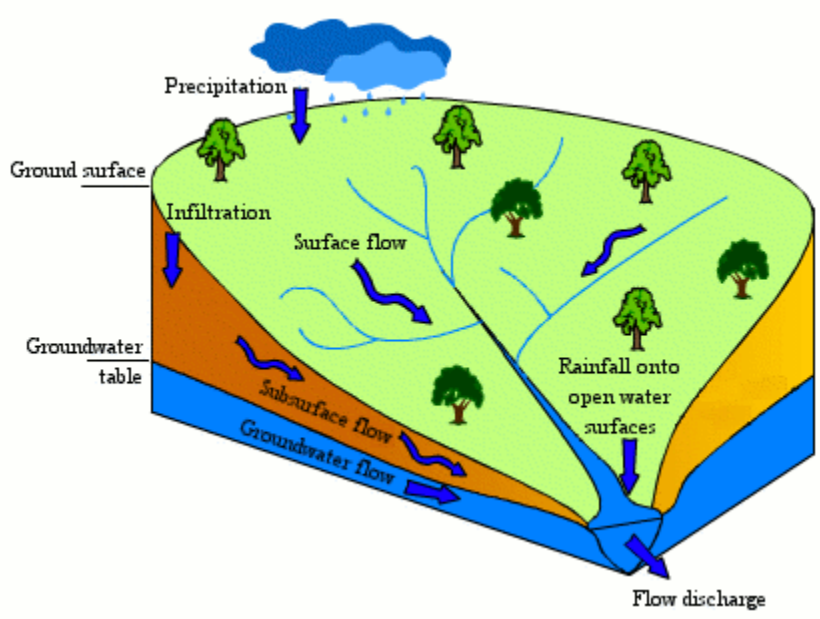

Figure 2: The infiltration process depending on soil type and flow

Penetration administration i(t) relies on upon the supply administration (watering system, sprinkle), additionally on soil properties. The aggregate infiltrationi(t), is the aggregate sum of water invaded throughout a given period.

$$I(t) = \int_{t=t_0}^{t} i(t)dt$$

where:

I(t) the cumulative infiltration during the t period (mm)

i(t) the infiltration regime during the t period (mm/h)

Water driven conductivity at immersion ks, is a key parameter of penetration. It speaks to the constraining worth of invasion if the dirt is immersed and homogenous. Permeation is the vertical water stream in soils (permeable nature's domain) on the groundwater layer affected by gravity. This methodology takes after invasion and has a real impact on the underground layer water supply.

Net sprinkle is the measure of rain that tumbles to the ground surface throughout a shower. The agreeable downpour is derived from the aggregate drizzle, decreased by the blocked portion of vegetation and that which is put away in ground dejections. The distinction between the penetrated drizzle and the emptied rain on the ground surface is called creation capacity.

1.4.2 Factors which influence infiltration

The main factors that influence the infiltration are:

- the soil type (texture, structure, hydrodynamic characteristics). The soil characteristics influence capillary forces and adsorption;

- the soil coverage. Vegetation has positive influence on infiltration by increasing the time of water penetration in soil;
- the topography and morphology of slopes;
- the flow supply (rain intensity, irrigation flow);
- the initial condition of soil humidity. Soil humidity is an important factor of infiltration regime. The infiltration regime evolves differently in time for dry or wet soils;
- soil compaction due to rain drop impact and other effects. The use of hard agricultural equipment can have consequences on the surface layer of soil.

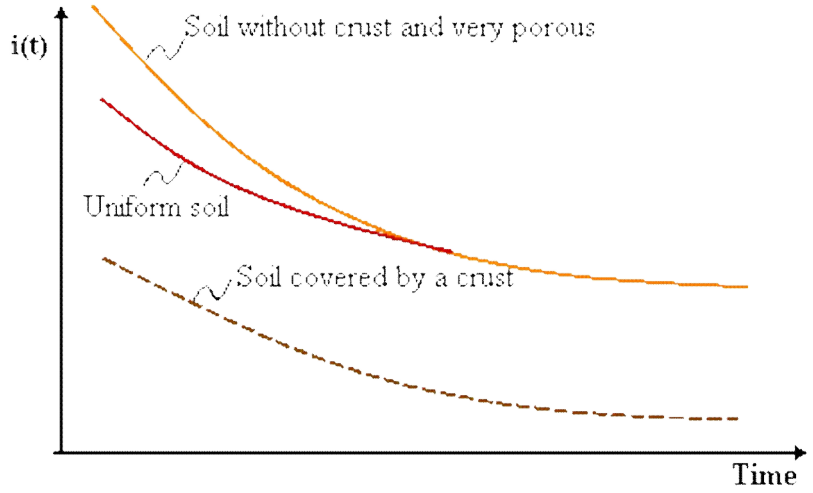

Figure 3: the infiltration regime depending on time for different types of soil

CHAPTER 2

REVIEW OF LITERATURE

J.H., Gregory et. al (2005) expressed that Infiltration is the methodology by which water moves descending at the soil surface pass in the soil. This system influences surface runoff, soil erosion, and groundwater recharge. In numerous orders the surface invasion rate is important to measure. The double-ring infiltrometer is regularly utilized for measuring invasion rates. The utilization of more modest diameter inner and outer rings (15 and 30 cm, separately) with a constant head gave comes about that were factually higher than the ASTM standard test and the falling head test with little rings. The set-up of the double-ring infiltrometer with the Mariotte siphon, as depicted in this paper is a proficient technique for leading a double-ring infiltrometer test. The Mariotte siphon consequently keeps up a constant head in the inner ring, while the head in the outer ring is kept up physically (a second Mariotte siphon could be utilized for this). This testing technique thusly just obliges one man to keep up the head in the outer ring and record the change in water level in the siphon .The consequences of the measured penetration rates from the three diverse testing strategies. Measured penetration rates on the sandy soil went from 22 to 225 mm/h and normal 143 mm/h over all tests. These rates are illustrative of modestly compacted fine sandy soils, for example, has been reported on pasture destinations.

Adindu Ruth Uloma et al. (2014) expressed that Infiltration rate is the procedure of water development starting from the earliest stage into the dirt. The real rate at which water enters into the dirt at any given time is termed as the invasion rate . This rate depicts the limit of a dirt to retain water. Penetration is interfaced with surface overflow and groundwater revive . It is likewise utilized within displaying, watering system plan and numerous characteristic and man-made methods . It is additionally utilized as a part of the determination of soaked pressure driven conductivity of soil layers. Invasion comparisons

are vital in planning and assessing surface watering system frameworks. This paper connected the experimental kostiakov's penetration display on the sandy soils of Ikwuano -Umuahia, with a specific end goal to focus the invasion model parameters of the dirts. Field estimations of penetration were made utilizing a twofold ring infiltrometer throughout the wet season . Readings were taken at 5, 10, 15 and 30 minutes interims. This paper likewise looks to spare time and expense of field estimation throughout soil water administration and water asset progressive practices here since the anticipated penetration parameters could be utilized. Soil penetration rate pattern appeared to be identified with the moderately framework potential angle of the dirt and likewise diminishes with the increment of wetted soil profundity. Penetration rates (IR) qualities were low. This is ascribed to the high dampness substance of the dirt since the investigations were led in stormy (wet) season. He likewise noted that, with even the same soil composition alternate variables can exchange to cause noteworthy contrast in the penetration rates of soils.

A.I. JOHNSON (1963) recommended that various components impact the penetration rate. Entrance depends on the compound physical state of the deposit and the water driven characteristics of the water in those residue, both of which may change with time. The invasion rate is impacted by the silt (soil) surface and structure, the state of the residue surface, the spread of soil dampness or soil-dampness strain, the physical and compound nature of the water, the leader of the supplied water, the ground water profundity, the time compass of requisition of water, biotic development, the temperature of the water and the deposit, the rate of caught air in the sediment, the air weight, and the kind of supplies or framework used. The rate of entrance is affected colossally by the vulnerability of the dregs. Regularly the residue are unsaturated when an infiltration test is started, and the penetration rate would not pose as a viable rival, altogether under flawless field conditions, with the vulnerability as consistently chose in the exploration office. Penetration rate typically is dead set from field information. Numerous diverse

techniques and sorts of supplies have been utilized for measuring invasion rate, however the essential systems are flooding of bowls or grooves, sprinkling (to recreate rain), and measuring water entrance from chambers (infiltrometer rings). The rate of subsidence of the water surface, or the rate of stream needed to keep up a steady level in an expansive bowl, or a huge ring infiltrometer is taken as a measure of the penetration rate. On the off chance that more diminutive infiltrometer rings are utilized, the rate of stream or subsidence for the period throughout which the wetting front is moving descending through the encased some piece of the dirt section is taken as the penetration rate. The rate of penetration is influenced enormously by the porousness of the silt. Normally the residue are unsaturated when a penetration test is begun, and the invasion rate couldn't relate, considerably under perfect field conditions, with the penetrability as typically decided in the research center. That is, the standard research center porousness parallels the invasion rate just when the silt are soaked. In figuring part change over the volume of fluid utilized throughout each one measured time interim into an incremental invasion speed for both the internal ring and annular space. soil. The volume penetrated throughout timed interims is changed over to an incremental penetration speed, typically communicated in centimeter for every hour or inch for every hour and plotted versus slipped by time. The greatest enduring state or normal incremental penetration speed, contingent upon the reason/provision of the test is equal to the invasion rate.

Ahaneku I.E. (2011) Crop gainfulness might be influenced by the invasion attributes of soils, which relies on upon the dirt physical properties, to be specific pressure driven conductivity, mass thickness, cone file, porosity and forerunner soil dampness content. Soils with high penetration rate or sorptivity could store water which will be advantageous to ahead of schedule sown yields without consistent precipitation. Invasion estimations utilizing ponded infiltrometers offers a finer option in the tropics where precipitation penetration frequently happens under ponded conditions. To enhance the penetration

rate of these tropical soils, agrarian practices that build soil natural matter and conglomeration, and diminish soil unsettling influence and compaction are upheld. Such practices incorporate preservation culturing, utilization of high buildup products and spread harvests. From the aggregate invasion bends, it is conceivable to figure out to what extent it will take to invade a certain measure of water. This has suggestions for watering system booking and surge control.the aftereffects of this study indicates that sandy topsoil has more ideal soil physical properties than sandy dirt so far as soil infiltrability and run-off diminishment are concerned.

Mohammad Farhan Bin Salleh (2006), the extent of water from precipitation or snowmelt that enters the dirt relies on upon home time (to what extent the water stays on the surface before running oft) and the invasion rate. These are influenced by vegetation and numerous soil properties. There are numerous elements that impact the penetration rate, for example, the state of the dirt surface and its vegetative spread, the properties of the dirt, for example, its porosity and water powered conductivity, and the flow dampness substance of the dirt. Soil strata with distinctive physical properties may overlay one another, shaping skylines; for instance, a residue soil with moderately high generally high pressure driven conductivity may overlay a mud zone of low conductivity. Likewise, soils display incredible spatial variability even inside moderately little ranges, for example, a field. As a consequence of these extraordinary spatial varieties and the time in soil properties that happen as the dirt dampness substance changes, penetration is an extremely unpredictable process that could be portrayed just give or take with numerical Equations. Soil profundity controls the amount water the dirt can hold. At the point when soil over an impermeable layer, for example, bedrock, gets immersed, invasion stops and overflow expands .The properties that influence penetration and might be promptly changed by administration or a movement in vegetation. Ceaseless pores joined with the surface pass on water. Such creatures as night crawlers, ants, and termites expand the amount of pores. Termites, on the other hand, can diminish the

penetration rate by decreasing the measure of litter spread, and some ground dwelling insect species seal the surface around their homes.

SajidMahmood & Muhammad Latif (2003) Cumulative penetration into the dirt profile throughout steady on-off process durations of surge watering system was evaluated utilizing surge-ring infiltrometer information. The Kostiakov comparison was utilized to model the total invasion conduct and its decrease into the dirt throughout distinctive surges. The two-point method was connected to focus the obscure parameters of the Kostiakov mathematical statement. It was presumed that the surging phenomena considerably lessened water development and the decrease in aggregate penetration differs from 60 to 83% throughout first surge and 60 to 27% for the ensuing surges. The utilization of surge watering system can possibly lessen invasion. The invasion conduct under surge watering system was resolved with the assistance of a surge-ring infiltrometer and the decrease in total penetration was additionally assessed. Another and straight send procedure has been introduced for creating combined penetration information of later surges from the first surge and utilizing surge-ring infiltrometer information. The watched and anticipated total penetration for second, third and fourth surges indicated a reasonably great assention. This data would be useful in watering system reproduction and displaying and additionally in outline and assessment and correlation of surge watering system with its partner. The surge-ring infiltrometer has potential for making an on-off instrument and is best suited to focus the combined penetration from surges for steady on-off time surge interims. Further testing is required before its reception at field level, utilizing differing process durations. The two-point system for the Kostiakov comparison was found to depict best the relationship between invasion time ti and water profundity Zi utilizing a surge ring infiltrometer.

Scott Andres et. al (2010) reasoned that hydrogeologic examination of a fast invasion bowl framework (RIBS) at CHSP was utilized to create an applied model of the hydrogeologic system in the region of the penetration bowls and adjacent release zone. The water-table aquifer exists in geographically junior (<1000 years) hill, spit, marsh, and bog stores. There is an underlying defective limiting layer structured by marine stores. Invasion testing of hill stores in the vadose zone shows that these stores are unreasonably overall emptied. Slug tests show that the water-table aquifer is modestly porous. Groundwater stream is determined by wastewater release, topographic, and climatic variables. There are no obvious tidal compelling variables. The impacts of storms and wastewater release on the water-table aquifer are unmistakably demonstrated in water levels and temperatures measured by information logging instruments. These information indicate that wastewater release is the overwhelming driving instrument driving most spill out of the penetration cots to a swampy release zone spotted adrift level and between 250 and 330 ft south of the invasion bunks. An indeterminate, yet thought to be minor measure of stream, is guided from the penetration cots towards the north. Future dissection of geochemical information will furnish extra proof with which to assess stream headings and extents.

Sebastien Fortin (2002) Discussed about the four sorts of infiltrometerfied analysis.in pressure infiltrometer the Wooding's mathematical statement for enduring state unconfined (three dimensional) penetration rates is utilized within computation water driven conductivities.in single ring infiltrometer A system to ascertain the Ks from information got from a weight or ring-infiltrometer for both early-time and unfaltering state invasion was produced by Reynolds and Elrick (1990), Elrick and Reynolds (192) and Elrick et al. (1995). Their enduring state technique utilizes a shape component focused around Garder's (1958) relationship between pressure driven conductivity and network weight head. Wu et al. (1999) created new single-ring infiltrometer techniques that utilize a summed up answer for measure the field immersed water powered conductivity (Kfs). The Kfs qualities can either be ascertained from the

entire combined penetration bend (Method 1) or from the relentless state segment of the total invasion bend by utilizing a revision variable. The impact of layering on invasion estimation is time and position subordinate. For a constrained time of estimation, the layering impact is more significant when the underlying soil is closer to the surface. The time needed for the wetting front to achieve the interface of surface intermittence could be evaluated from the amendment element, f, and the combined penetration. In ponded infiltrometer throughout penetration occasions, the water enters the dirt because of potential inclinations of water potential and gravitational potential. The water potential term is legislated by the dryness of the dirt and the pore structure of the dirt. These two elements join together to structure a sorptivity component which is made up of the consolidated impacts of fine activity and glue powers to soil strong surfaces. The sorptivity of the dirt is regularly communicated as "S". The gravity term is a steady for diverse soils and is because of the effect the pore size, progression and appropriation on the rate of water move through soil affected by gravity. This term is known as "A". Infiltrometer tests are valuable for measuring the rate of invasion yet don't give an immediate measure of field-soaked pressure driven conductivity. Since captured air exists inside the wetting front, genuine immersed conditions don't structure throughout invasion tests. Experience demonstrates that field immersed Kfs is give or take 50-75% short of what Ks.in twofold ring infiltrometer states that as with the single ring infiltrometers the wetting front is permitted to development underneath the base of the ring, however it is accepted that penetration through the external ring capacities as a powerful obstruction to sidelong stream underneath the ring. Notwithstanding, the precision of this supposition may be restricted.

Claus Hoffjann et.al.(2008) A sterile gadget for independent operation for a transport. The sterile gadget has a clean module and a supply framework. The clean module is situated up supplant capably in a lodge region of the transport. The supply framework is situated up in the clean module to supply it. The clean module is self-sufficiently operable. There may be a need to give a clean gadget having high adaptability

for a movement. The need may be attained by a clean gadget for a movement and a system for working a sterile gadget for a transport and the utilization of a sterile gadget for operation in a transport and an air ship having a clean gadget having the peculiarities as indicated by the autonomous cases. As indicated by an commendable exemplification of the present innovation, a sterile gadget for self-ruling operation is accommodated a movement. The clean gadget has a sterile module and a supply framework. The clean module is situated up supplant capably in a lodge zone of the transport. The supply framework is situated up in the clean module, so that the sterile module is operable independently.

Dennis M. Anderson(1999) expressed that a strategy and gadget for deciding the water powered conductivity of permeable materials is revealed. The system utilizes a general penetrability comparison for figuring the water driven conductivity. The resistivity of the permeable material is measured when the permeable material is at any rate somewhat immersed with a pore. Other information, for example, a development element, porousness constants of the permeable material, and insitu dampness substance of the permeable material may likewise be inferred or measured. The geophysical porousness comparison is then used to figure the pressure driven conductivity of the permeable material from the estimations and information. Systems are likewise uncovered which give a normal pressure driven conductivity over a given region. A gadget for deciding water powered conductivity of a permeable material is revealed which uses a majority of anodes for directing power to the permeable material. A resistivity meter may be connected between the cathodes for measuring the resistivity. The gadget may incorporate a terminal situating gadget for situating the cathodes in a foreordained extraordinary relationship.

Srinivasan.k and Poongothai.s (2013) inferred that the current study decided consistent state invasion rates of distinctive soil sorts in chose zones of Wellington supply in Tittagudi taluk, Cuddalore area, Tamilnadu. Well sand, poor sand, poor earth and well were distinguished and their enduring state

invasion rates went from 8.4 – 19.2, 13.2 – 21, 7.2 - 18 and 5.4 – 30 cm/hour, separately. Well sand soil has the most noteworthy starting and consistent invasion rates because of the way that it has coarse surface and expansive permeable spaces which push quick penetration. The measured penetration rates were higher than the fundamental qualities which were ascribed to nearby varieties in soil structure. The measured invasion rates are noteworthy in forecast of surface overflow, soaked water driven conductivity of surface layers and groundwater revive, and creating or selecting effective watering system routines. Considers on invasion rates of soils are needed in tackling numerous hydrological issues, for example, overflow estimation, soil dampness planning watering system arranging, area use arranging and administration. This exploration indicates that vegetation spread is a standout amongst the most paramount variables that quickens penetration rate and subsequently diminishes overland stream which and at last in turns rations the dirt. The territory is unacceptable for surface watering system because of its high penetration limit. It is proposed that human exercises as deforestation, bramble copying and brushing by domesticated animals ought to be disheartened, while around there; planting of trees on desolate grounds ought to be urged to lessen disintegr

Hsin-yuShan(1995) taken fundamental presumptions as those for open ring infiltrometers. Don't have to consider the volume change of soil before the stream rate gets steady. The internal ring is seal. Don't have to revision for vanishing. Especially suitable for soils low pressure driven conductivity. Measure vertical pressure driven conductivity. Don't have to right for bearing of stream. Stream from internal ring might be dealt with as one-dimensionally descending.

JagdaleSatyawanDagadu and Nimbalkar P. T. (2012) The consistent invasion rates of distinctive soils under diverse soil conditions were ascertained at Sangola, locale solapur of Maharashtra district. Experimentation work was completed on dark cotton, mud, and sandy soil. Soil conditions considered

for dark cotton soil were compacted, furrowed, and harrowed, for mud soil unploughed and furrowed, and for sandy soil unploughed. The twofold ring infiltrometer system was utilized for estimation of penetration rate. The study intended to focus steady penetration rates of those dirts under diverse soil conditions and contrasting it and the invasion rates got by Kostiakov, Modified Kostiakov, Horton's and Green-Ampt penetration models. The qualities of different constants of the models were figured by system for midpoints proposed by Davis (1943), and by graphical methodology. For getting best fitting model for specific soil and soil condition the results acquired from different invasion models were contrasted and watched field information and diagrams were drawn. The parameters considered for best fitting of model were connection coefficient and standard failure. The results indicated that, The Horton's model, and Green – Ampt model were best fitting to watched field information to gauge penetration rates at any given time with high level of association coefficient and least level of standard blunde

TAREK Selim (2011) reasoned that the introductory penetration rate depended predominantly on the starting water content in substantial clayey soil. The penetration rate was influenced by the measure of splits created by plant roots, earth development and parching of mud. The fish cultivate in overwhelming clayey soil did not build the dirt penetrability acknowledge the top layer (mud layer) because of the vicinity of extensive number of wide and profound splits coming about because of drying up, yet didn't enhance the porousness of the undeveloped layer. The characteristic soil had a high penetration rate contrasted with alternate fields because of the profound breaks in the dirt and the low introductory water content. This results agreeing with the color tests directed by the creator in the same study range (Abou Lila et al., 2005).estimates of penetration focused around hydrograph examines have the playing point over infiltrometers of relating all the more straightforwardly to predominating states of

precipitation and field.to get invasion bend utilizing Horton's Equation.to focus the penetration parameter utilizing Horton's Equation.

John Diamond and Thomas Shanley (2003) Infiltration limit was sensibly steady over an eight year period and likewise invasion tests can have a part in surveying the long haul danger of overland stream and the copartnered contamination peril. Considerable variety happened inside locales and the variety was more amazing in winter than in summer. All in all, for 50 percent exactness, eight estimations are needed in summer, and fourteen in winter, on locales made out of a solitary soil arrangement or stage. A correspondingly more terrific number will be needed ashore territories made out of various soils. Invasion tests performed in summer are best, as tests performed in winter are unrealistic to reflect stable soil aspects. To survey the danger of overland stream over the entire year, extra data will be needed on the span and level of wetness. In spite of the fact that the mean distinction between day 1 and day 2 was not measurably critical, the two-day test is alluring to lessen the danger of overestimates at individual destinations. There was a purported occasional impact, which was ascribed to the impact of precursor soil water content on the measured invasion limits. In summer, invasion limit was on normal 3.5 times the winter rate. But on an impermeable Gley, the penetration limit in summer equalled or surpassed the hourly precipitation expected once in five years. This infers that the danger of overland stream is liable to be little in summer on openly emptied soils that have not been compacted by creatures or machines. Watering system rates of 5 mm hahr-1 or 2.5 mm hrhr-1, allowed by the Code of Good Agricultural Practice, surpass the penetration limit of a few soils, including free emptying soils, in winter. This suggests that there may be a huge danger of overland stream in winter.

CHAPTER 3

STUDY AREA AND DATA COLLECTION

3.1 NIT Rourkela

National Institute of Technology, Rourkela in Odisha, INDIA (NIT previously known as the Regional Engineering College Rourkela (REC Rourkela), is an publicly supported designing and engineering college spotted in the city of Rourkela, Odisha, India. It was secured in the year 1961 by a joint undertaking of the legislature of India and the administration of Odisha.

3.2 History

NIT Rourkela was made in 1961 under the Chief Minister of Orissa, BijuPatnaik and its establishment stone was laid by the Prime Minister Of India, Pt. Jawaharlal Nehru to pander to the Nation's requirement for developing labor gifted in the ranges of engineering. While being a Regional Engineering College for all the former years, it was conceded independence and utilitarian autonomy by the Ministry of Human Resource Development in the year 2002 accordingly turning into one of the National Institutes of Technology. The foundation has two community financing orgs, the Material subject in the Materials and Metallurgical Engineering division under Indo-U.k. REC venture and the Computer Science and Electronics streams under World Bank cum Swiss Development Corporation IMPACT venture. The current Director of the establishment is Prof. S.kSarangi.

3.3 Location

The city of Rourkela is an expansive city joined with all parts of the nation by track and way. The number of inhabitants in the city is about 6.5lakhs. The establishment is at a separation of something

like 7 km from the line station. The yard of the foundation comprising of the establishment structures, lobbies of habitation and staff province is arranged at the eastern end of Rourkela steel city, past Sector-1 over a range of 462 hectares of area gave by the Government of Orissa. The closest runway to Rourkela is Ranchi at a separation of 172 kilometers.

3.4 Infrastructure

The yard of the foundation is arranged at the eastern end of Rourkela steel city, past Sector-1 over a region of 4.62 km² (1142 Acres) of area gave by the Government of Orissa which makes it the biggest building facilities in the nation after IIT Kharagpur. The courses are for the most part private on a full-time premise. The foundation territory is at the core of the yard and encompassed by the neighborhoods. The primary building of the Institute is integral to the organization territory and is encompassed by the departmental structures. It houses all the classrooms, the Central library, and the Administrative and Academic segments. It likewise houses offices like Physics, Chemistry, Mathematics and Humanities. All the divisions, the address exhibition, the workshops, the organization container and the varying media-lobby encompass the principle building. Private settlement is given to all staff, staff and understudies. There are nine corridors of living arrangement for the scholars inside the yard: Six for male graduates and postgraduates, two for female understudies and one for wedded learners seeking after doctorate degrees and past or full-time research. The private yard is outfitted with a stadium which has been host to a few national level college competitions and is named after DilipTirkey, the previous Indian Hockey chief who hails from this some piece of Orissa. There are different courts close to the lodgings for playing garden tennis, ball and volleyball. A swimming pool and a stadium devoted completely for cricket have been constructed.the assessed expense of the oceanic focus has been evaluated to be 6.5 crores.the cricket ground is generally outfitted with floodlights and a players'

changing area. The grounds has all the pleasantries for creating particular, social and scholarly aptitudes of the scholar group. The foundation has been institute of matriculation-to some conspicuous hockey, cricket , ball, table tennis, football and sports abilities who have partaken in different state and national level diversions. Indoor gaming office like table tennis, badminton, carom are all served in the particular inns. Every inn likewise has two volleyball courts. The Student Activity Center (SAC) inside the focal scholarly range is the center point of all additional scholastic interests and is the fundamental sorting out office for all scholar symposiums, yearly occasions and is served by the roughly 800 seater Bhubaneshwar Behera Audio Visual Auditorium and a give or take 800 seater outdoors theater. The establishment is served by an on facilities dispensary and the completely prepared Community Welfare Service (CWS) Hospital for therapeutic medications. All private and non-private people are safeguarded for all therapeutic costs by the organization. The person co-agent store encourages buy of books and stationery at lessened costs. The on yard postal administration is the state claimed India Post. The official on facilities financier to scholars and the organization is the state run State Bank of India (REC Campus)

3.5 Climate Profile of NIT Rourkela

3.5.1 Temperature

All around the month of December daytime temperatures will for the most part achieve highs of around 24°c that is about 75°f. Around evening time the normal least temperature drops down to around 10°c that is 50°f. As of late the most elevated recorded temperature in December has been 31°c that is 87°f, with the least recorded temperature 2°c, something like 35°f. All around the month of January daytime temperatures will for the most part achieve highs of around 24°c that is about 75°f. Around evening time

the normal least temperature drops down to around 9°c that is 49°f. As of late the most elevated recorded temperature in January has been 30°c that is 86°f, with the least recorded temperature 3°c, something like 38°f. All around the month of February daytime temperatures will for the most part achieve highs of around 27°c that is about 80°f. Around evening time the normal least temperature drops down to around 11°c that is 52°f. As of late the most elevated recorded temperature in February has been 35°c that is 94°f, with the least recorded temperature 4°c, something like 38°f. All around the month of March daytime temperatures will for the most part achieve highs of around 31°c that is about 88°f. Around evening time the normal least temperature drops down to around 17°c that is 62°f. As of late the most elevated recorded temperature in March has been 39°c that is 102°f, with the least recorded temperature.

3.5.2 Relative Humidity

The normal day by day relative moistness for December is around 59%. The normal day by day relative moistness for January is around 54%. The normal day by day relative moistness for February is around half. The normal day by day relative moistness for March is around 40%.

3.5.3 Heat Index

The Heat Index is a measure of how hot it feels when relative mugginess is added to real air temperature. From this a solace level is computed giving classes on how high temperature conditions may antagonistically influence somebody. Solace Levels: Given normal most extreme temperatures and mugginess levels by and large you ought not expect any inconvenience from high temperature (see hotness file for more data). The Heat Index is a measure of how hot it feels when relative moistness is added to genuine air temperature. From this a solace level is ascertained giving classifications on how

high temperature conditions may antagonistically influence somebody. Solace Levels: Given normal greatest temperatures and moistness levels by and large you ought not suspect any uneasiness from high temperature (see hotness file for more data). The Heat Index is a measure of how hot it feels when relative moistness is added to genuine air temperature. From this a solace level is ascertained giving classifications on how high temperature conditions may antagonistically influence somebody. Solace Levels: Given normal greatest temperatures and mugginess levels for the most part you ought not suspect any inconvenience from high temperature (see hotness record for more data). The Heat Index is a measure of how hot it feels when relative dampness is added to real air temperature. From this a solace level is figured giving classifications on how high temperature conditions may antagonistically influence somebody. Solace Levels: Given normal greatest temperatures and mugginess levels for the most part you ought not suspect any inconvenience from high temperature (see hotness record for more data).

3.5.4. Precipitation

The normal month to month measure of precipitation has been recorded at around 10 mm, that is 0 inches. All around the month you can hope to see rain or sprinkle falling on 1 days of the month. The normal month to month measure of precipitation has been recorded at around 15 mm, that is 1 inches. All around the month you can hope to see rain or sprinkle falling on 4 days of the month. The normal month to month measure of precipitation has been recorded at around 22 mm, that is 1 inches. All around the month you can hope to see rain or sprinkle falling on 3 days of the month. The normal month to month measure of precipitation has been recorded at around 21 mm, that is 1 inches. All around the month you can hope to see rain or sprinkle falling on 4 days of the month.

3.5.5 Estimated Hours of Sunshine per Day

We compute daylight hours for every day utilizing our past conjecture information. For December anticipate that the sun will sparkle for a normal of 10 hours for every day. This speaks to the normal number of hours in the daytime that the sun is noticeable and not clouded by cloud e.g. the normal number of hours the sun is really out and sparkling. Note we figure hours of daylight for every day utilizing our past estimate information, not perception information, subsequently it is an evaluation and not genuine. We compute daylight hours for every day utilizing our past gauge information. For January anticipate that the sun will sparkle for a normal of 10 hours for every day. This speaks to the normal number of hours in the daytime that the sun is unmistakable and not darkened by cloud e.g. the normal number of hours the sun is really out and sparkling. Note we ascertain hours of daylight for every day utilizing our past estimate information, not perception information, consequently it is an assessment and not genuine. We ascertain daylight hours for every day utilizing our past conjecture information. For February anticipate that the sun will sparkle for a normal of 11 hours for every day. This speaks to the normal number of hours in the daytime that the sun is obvious and not clouded by cloud e.g. the normal number of hours the sun is really out and sparkling. Note we figure hours of daylight for every day utilizing our past estimate information, not perception information, along these lines it is an assessment and not genuine. We ascertain daylight hours for every day utilizing our past conjecture information. For March anticipate that the sun will sparkle for a normal of 11 hours for every day. This speaks to the normal number of hours in the daytime that the sun is obvious and not clouded by cloud e.g. the normal number of hours the sun is really out and sparkling. Note we figure hours of daylight for every day utilizing our past estimate information, not perception information, along these lines it is an assessment and not genuine.

3.6Soil quality

3.6.1 Classification

Sandy topsoil soils are broken down into four classes, including coarse sandy dirt, fine sandy dirt, sandy topsoil and fine sandy dirt. The extent of the sand particles is measured in millimeters and their focus in the dirt is utilized to figure out which classification a dirt falls under. Sandy topsoil soils are made of pretty nearly 60 percent sand, 10 percent earth and 30 percent sediment particles.

3.6.2 Characteristics

Sandy topsoil soils have noticeable particles of sand blended into the dirt. At the point when sandy dirt soils are layered, they hold their shape however break separated effectively. Sandy topsoil soils have a high amassing of sand that provides for them a lumpy feel. In enclosures and yards, sandy topsoil soils are fit for rapidly emptying abundance water however cannot hold noteworthy measures of water or supplements for your plants. Plants developed in this kind of soil will oblige more regular watering system and treatment than soils with a higher amassing of dirt and dregs. Sandy topsoil soils are regularly insufficient in particular micronutrients and may require extra preparation to help sound plant development.

3.7 Data collection

The monthly Infiltration rate at particular time intervals are collected and analysed from two selected sites of NIT Rourkela, Odisha, India during the months between October to March in the year 2013-2014.The Infiltration rate and the Incremental Infiltration are calculated depending upon the cumulative time interval of the infiltration.

CHAPTER 4

MATERIALS & METHODOLOGY

4.1 Materials required

4 no. of Cylindrical ring infiltrometer (height=60cm,diameter 15cm,30cm,45cm,60cm),Wooden piece (to drive the cylinder inside the soil), Hammer (to dig the cylinder inside the soil without any disturbance in the soil surface), Measuring bucket of 3no. (12lt, 13lt,20lt), Measuring jar (2lt), Metal plate, Long pipe, Stopwatch (to know the time interval in which infiltration has to be measured), Tape & scale (the amount of water penetrate inside the soil within a specific time interval), Cover & plastic sheet, Stationary use, Wash cloths.

4.2 Procedure

Anregion at garden and forest on the University of NIT campus, Rourkela was used to conduct the test by using double ring infiltrometer. Area of 4m by 10m was taken in both the habitation. The amount of infiltration rate and incremental infiltration rate can be accomplished by using the apparatus double ring infiltrometer. A duos of both side unwrapped stainless steel rings are used whose diameter are 15-30cm,15-45cm,30-45cm,30-60cm & of height60cm. One side of the ring will have a cutting edge so that it willget-up-and-go inside the soil surface easily without any damage to the soil or to the cylinder. Two cylinders will be digged inside the soil where the measurement will be taken in the inner cylinder only and the outer cylinder will help to flow the water perpendicularly& not alongside. The metal plate will shield the soil surface of the inner cylinder so that it can reduce the force of water poured inside the cylinder. The cylinders are of height 60cm which are been diggedupto a height of 50cm inside the soil with the aid of wooden piece and hammer. Cylinder will be kept back 10cm above the ground surface in

which the water will be poured and the measurement will be taken out. The measured amount of water will be poured inside the inner cylinder so that the measurement will be taken with respect to the time break and the dispersion of water level in the inner ring. The measurement was continual until and unless a fixed rate of infiltration was achieved. In one place for constantly 5 to 6days infiltration readings were taken so that the amount of infiltration rate can be acknowledged. At a time interval of 5mins or 10mins were taken and the fall in the water level was measured.

Figure: 4. double ring infiltrometer

Water was measured by the measuring jar and poured in the bucket. Then the inner ring and outer ring was filled with water at the same time. 5mins and 10mins interval was taken to measure the drop of water inside the inner ring only. A long scale was used to measure the depth of water infiltration.In this way the garden and forest area readings were taken so that a comparison can be made between the two places. From this it can be concluded that which place will be better for construction work and which place will be better for agricultural work. As forest area infiltration rate is high it can be used for both purposes. If an agriculture land faces problem during the cultivation then at that point of time double ring infiltrometer can be used. By the help of which water can directly percolate to the ground surface and to the all portion of the plant which requires water to grow the plant. In this method water logging area can be taken into consideration. The places which are water logged, the double ring infiltrometer

can be used there from where the water will directly percolate towards the ground water and recharge it without any loss or wastage of water.

4.3 SOIL TESTING

Soil test is the dissection of a soil specimen to focus supplement and defiled substance, piece, and different aspects, for example, the sharpness or ph level. A soil test can focus ripeness, or the normal development capability of the soil which demonstrates supplement insufficiencies, potential toxicities from extreme fruitfulness and restraints from the vicinity of insignificant follow minerals. The test is utilized to copy the capacity of roots to absorb minerals. oil science changes about whether, as organic and synthetic courses of action break down or join mixes about whether. These courses of action change once the soil is expelled from its regular environment (verdure that infiltrate the inspected region) nature (temperature, dampness, and sunlight based light/radiation cycles). Therefore, the compound arrangement dissection exactness could be enhanced if the soil is broke down not long after its extraction — normally inside a relative time of 24 hours. The compound changes in the soil could be impede throughout capacity and transportation by solidifying it. Air drying can likewise save the soil test for a long month

4.3.1 Permeability

Because of the presence of the between joined voids, soils are penetrable. The penetrable soils will permit water stream from purposes of high vitality to purposes of low energy.permeability is the parameter to portray the capability of soil to transport water.

4.3.2 Regression analysis & best fit trend line

The most vital presentation of Least Square Method is data suitable. The best fit in the Least-Squares sense diminishes the sum of squared residuals, a residual being the difference between an practical value & the fitted value providing by a model. Once the problem has considerable uncertainties in the independent variable (the '*x*' variable), then Simple Regression & Least Squares methods have problems; in such cases, the method is essential for fitting errors-in-variables models is well-thought-out in its place of the Least Squares.

The objective consists of correcting the values of a model function to best fit a record set. A simple data set consists of n points (data pairs of x_i, y_i), i vary from 1, 2, 3, 4… n where $x_i$is an independent adjustable and y_i is a dependent variable whose value is found by observation. The Model function has the form $f(x, \beta)$ where the n adjustable values of infiltration rate are held in vector β. The goal is to find the limit values for the model which "*best*" fits the data. The Least Squares method finds its optimum when the sum (∑) of the squared residuals is the minimum. A residual is defined as the difference between the real value of the dependent variable and the value expected by the model given as:

$$S = \sum_{i=1}^{n} R^2$$

whereR^2 = coefficient of correlation or determination coefficient. The value of R^2 between 70% to 100% are considered to have a solid bond.

Here R^2 is the analytical percentage of behaviour in the output that can be explained by input.

The Trend Analysis for the parameter is stared statically significant at $R^2 \approx 1$. In addition to formal numerical test, visual review of time series analysis is done.

4.3.3 Calculation of incremental rate

Alter the actual involving liquefied utilized in the course of each and every calculated time period in a incremental infiltration rate for both inner ring along with annular ring while using the next equations:For the inner ring calculate as follows:

$V_{IR} = \Delta V_{IR} / A_{IR} \cdot \Delta t$

Where *VIR* = inner ring incremental infiltration velocity, cm/h,

ΔV_{IR}= volume of liquid used during time interval to maintain constant head in the inner ring, cm^3,

A_{IR}= internal area of inner ring, cm^2, and

Δt = time interval, h.

For the annular space between rings calculate as follows:

$V_A = \Delta V_A / A_A \cdot \Delta t$

Where V_A= annular space incremental infiltration velocity, cm/h,

ΔV_A= volume of liquid used during time interval to maintain constant head in the annular space between the rings, cm^3, and A_A= area of annular space between the rings, cm^2.

4.3.4 ANN

The artificial neural network (ANN) has the proficience to gain from the example known some time recently. The artificial neural network can make forecasts on the premise of its past researching the yield identified with new enter information set; both set ought to be of same example. In the present study the water nature of Brahmani River was anticipated relying on the variety in water quality parameters. The standards in artificial neural network example were focused around immediate demonstrating of the human neuronal framework. The network might be characterized utilizing three key parts: exchange capacity, network structural engineering and taking in law.

Back Propagation calculation was the best taking in method in multilayer neural network structure. The food advance back propagation neural network (BPNN) was constantly comprised of no less than three layers: data layer, shrouded layer and yield layer . A network was required to be prepared before translating new data for the following methodology. Each one layer was comprised of neurons and every neuron was joined with the following layer through weights those were called neurons in the information layer which sent its yield as info for neurons in the concealed layer and comparable was the association between shrouded and yield layer. Number of shrouded layer and number of neurons in the concealed layer were changed as per the issue was to be explained. The amount of info and yield neuron was same as the amount of data and yield variables.

To separate between the diverse handling units, qualities were called as predispositions were presented in the exchange capacities and were alluded as the temperature of a neuron. The predisposition was similar to a weight and has a data of 1, while the exchange capacity separated the summed signs gained from this neuron. The exchange capacities were intended to guide neurons or layers net yield to its genuine yield and they were basic step works either direct or non-straight capacities. Aside from the info layer, all neurons in BPNN were connected with an inclination neuron and an exchange capacity. The provision of exchange capacities was relied on upon the motivation behind the neural network. Yield layer was prepared and the vectors comparing to the result was figured.

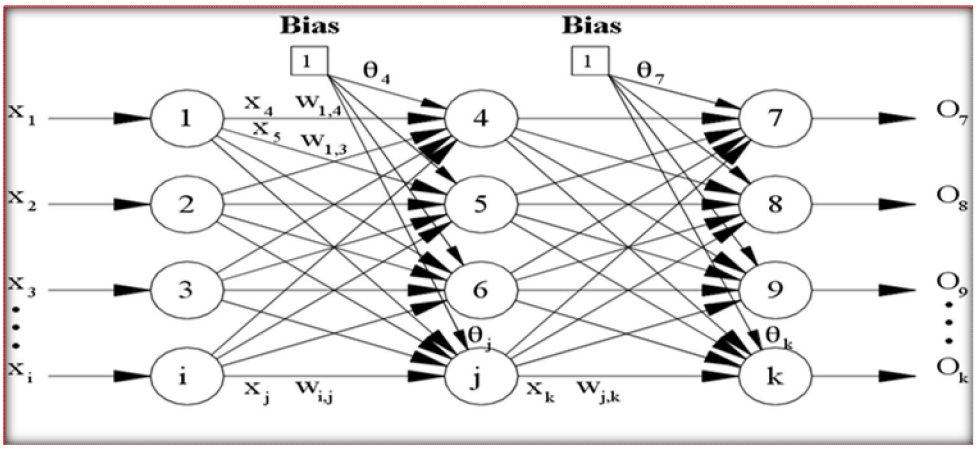

Figure 4.1: Back Propagation Neural Network

4.3.5 Components of Neuron

In segments of neuron, the greater part of the parts were depicted and were held in neural network. These segments were legitimate regardless of the fact that the neuron was utilized like information, yield and shrouded layer. A solitary neuron with fundamental components of an artificial neuron was depicted in Figure 4.8.

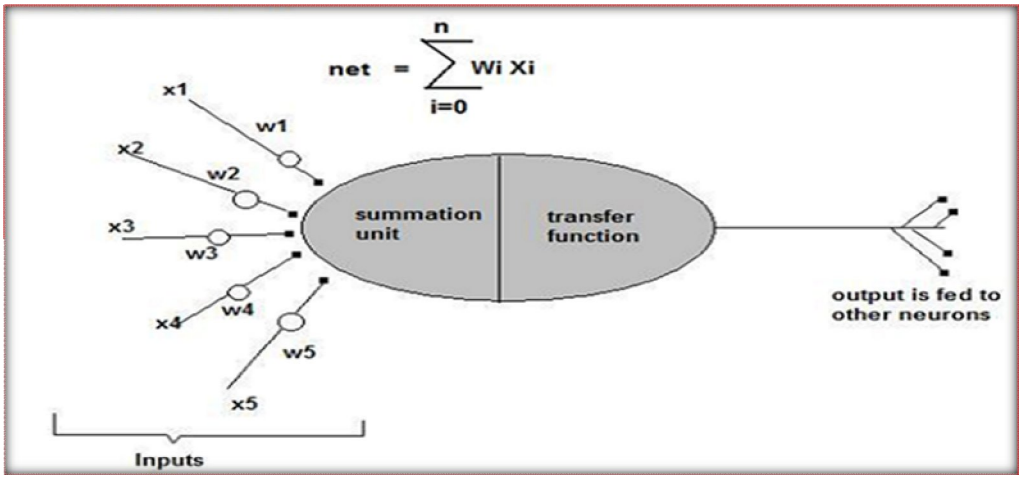

Figure 4.2: Basic elements Artificial Neuron

4.3.6 Weights

Commonly a neuron was accepted by numerous concurrent and various inputs. Each one data of the neural network had its own particular relative weight which gave the criticalness of the info inside the

initiation of the neuron. These weights were coefficients that could be adjusted inside the network to focus the power of info sign, was accepted by the artificial neuron. They were the measure of the quality of an information association. These powers were altered in light of the preparation cases as per the particular topology or due to the preparation standards.

4.3.7Horton's Equation

The infiltration process was thoroughly studied by Horton in the early 1930s. An outgrowth of his work, shown graphically in Fig. 7.1, was the following relation for determining infiltration capacity:

/p = /c + (fo - */c)e-kt*
where*/p* = the infiltration capacity (depth/time) at some time *t*

k = a constant representing the rate of decrease in / capacity

/ c = a final or equilibrium capacity

/0 = the initial infiltration capacity

It demonstrates that if the precipitation supply surpasses the infiltration capacity, infiltration has a tendency to reduction in an exponential way. Albeit basic in structure, troubles in deciding helpful qualities for/0 and k confine the utilization of this comparison. The zone under the bend for at whatever time interim speaks to the profundity of water penetrated throughout that interim. The infiltration rate is typically given in inches for every hour and the time t in minutes, albeit other time additions are utilized and the coefficient k is resolved likewise.

4.3.8 Error analysis

To know the rate of slip in information, evaluated information and anticipated information were finished with the assistance of certain numerical plans and estimations like Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE)

4.3.8.1 Mean Absolute Error (MAE)

The Mean Absolute Error (MAE) was the quantity used to measure how close forecasts and predictions were to the eventual outcomes. The mean absolute error can be given as:

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|f_i - y_i| = \frac{1}{n}\sum_{i=1}^{n}|e_i|, \tag{4.53}$$

Where e_i is the average absolute error, $e_i = |f_i - y_i|$, f_i is the prediction and y_i is the true value. The mean outright lapse was a typical measure of figure mistake in time arrangement investigation, where the terms 'mean supreme deviation' was now and again utilized as a part of perplexity with the more standard meaning of mean total deviation.

4.3.8.2 Mean Absolute Percentage Error (MAPE)

Mean Absolute Percentage Error otherwise called Mean supreme Percentage Deviation, was a measure of correctness of a system for building fitted time arrangement values in detail, particularly in pattern estimation. It was usually expressed as a percentage, and was defined by the formula as given below:

$$M = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|, \tag{4.54}$$

Where A_t is the actual value and F_t is the forecasted value.

Unquestionably the quality in this plan was summed for each fitted or determined point in time and was separated again by the amount of fitted focuses; n,multiplying by 100, it gave percentage error.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 Soil Testing

5.1.1 Permeability

The quantity of water discharge at a time interval of 5mins are 68ml,110ml& 180ml.

Permeability = $\frac{Q \times L}{A \times t \times h}$

$$P = \frac{180 \times 12.7}{76.97 \times 900 \times 241}$$

$$= 1.369 \times 10^{(-4)} \text{ cm/sec}$$

Where t = total time of discharge=15min

Q= quantity of water discharge=180ml

L= length of soil specimen=12.7cm

A=c/s area of the specimen=76.97cm², Dia = 9.9cm

h=head loss= 241cm

5.1.2 Soil Water Content

Empty weight of container = 21.80gm

Container with wet soil = 101.22gm

Container with dry soil = 90.19gm

Water content(w) in % = $\frac{wetsoil - drysoil}{drysoil - weightofcontainer} \times 100$

$$\frac{101.22 - 90.19}{90.19 - 21.80} \times 100$$

=16.128 %

5.2 Regression Analysis for Best Fit Trend Data

Trend analysis determines whether the measured values of aninfiltration rate with increase or decrease over a period. There are several statistical techniques available for trend analysis depending upon the characteristics data. The graphs and tables shows the best fit trend line and the values of R^2 from the equation extracted.

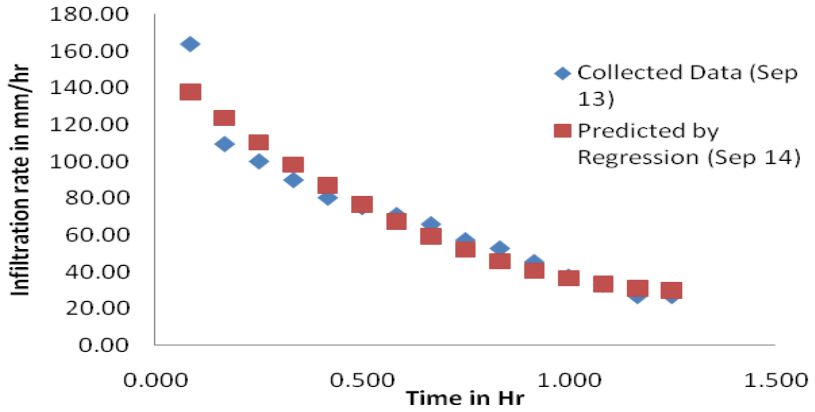

Figure 5.1 Infiltration Rate vs Time of Garden 15-45 Ring (Inner) for the Month of September

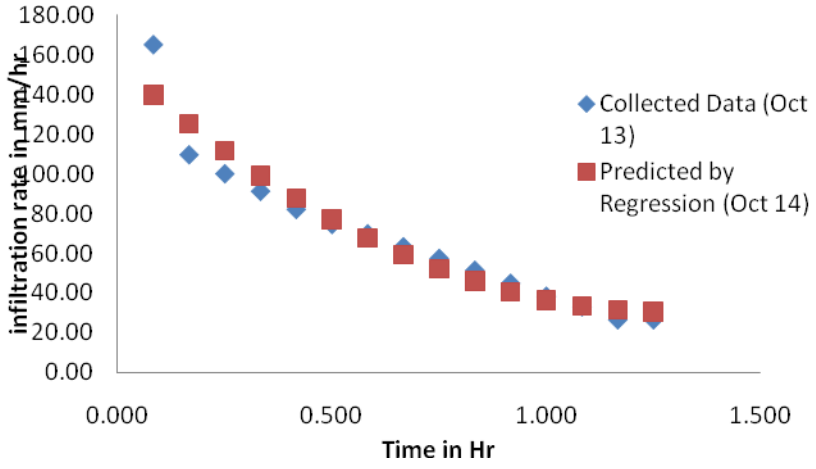

Figure 5.2 Infiltration Rate vs Time of Garden 15-45 Ring (Inner) for the Month of October

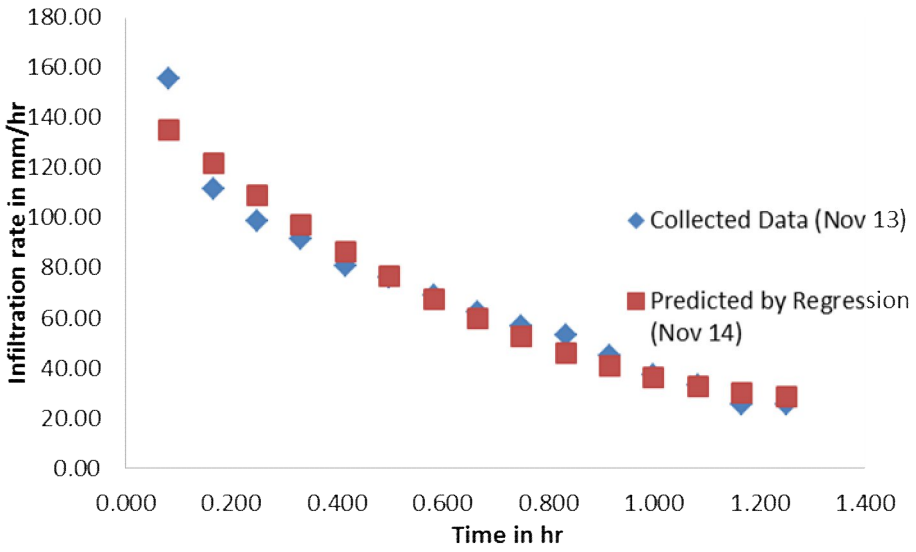

Figure 5.3 Infiltration Rate vs Time of Garden 15-45 Ring (Inner) for the Month of November

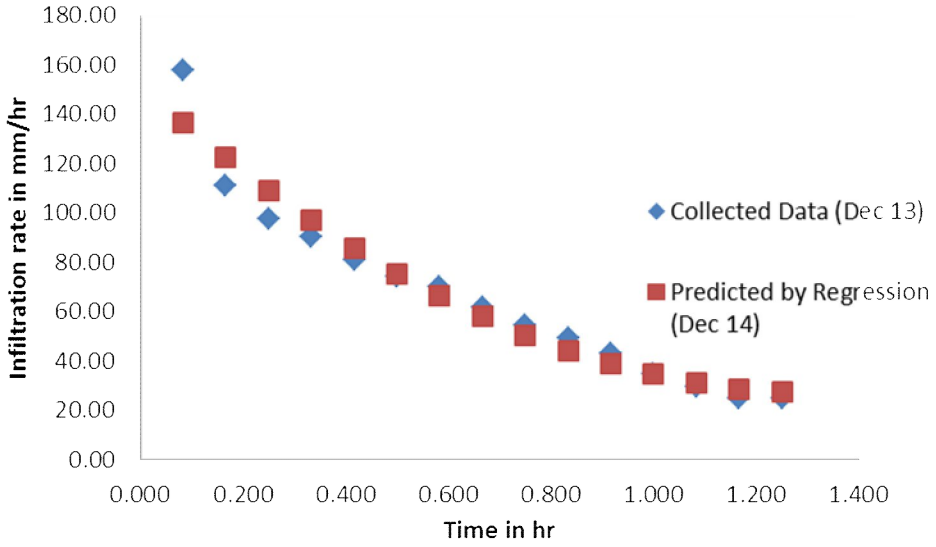

Figure 5.4 Infiltration Rate vs Time of Garden 15-45 Ring (Inner) for the Month of December

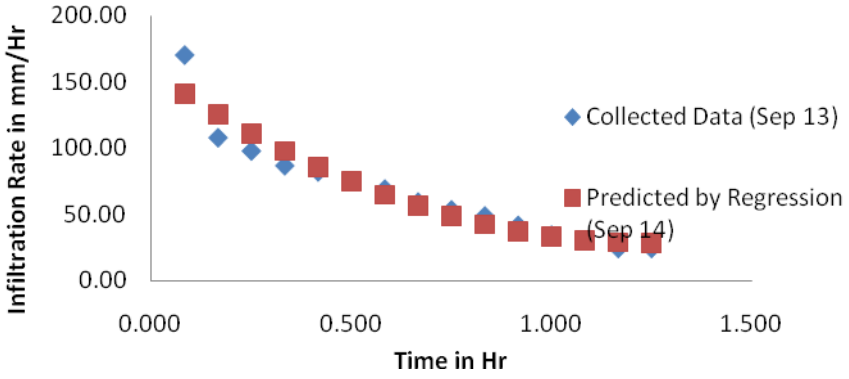

Figure 5.5 Infiltration Rate vs Time of Garden 15-45 Ring (Annular) for the Month of September

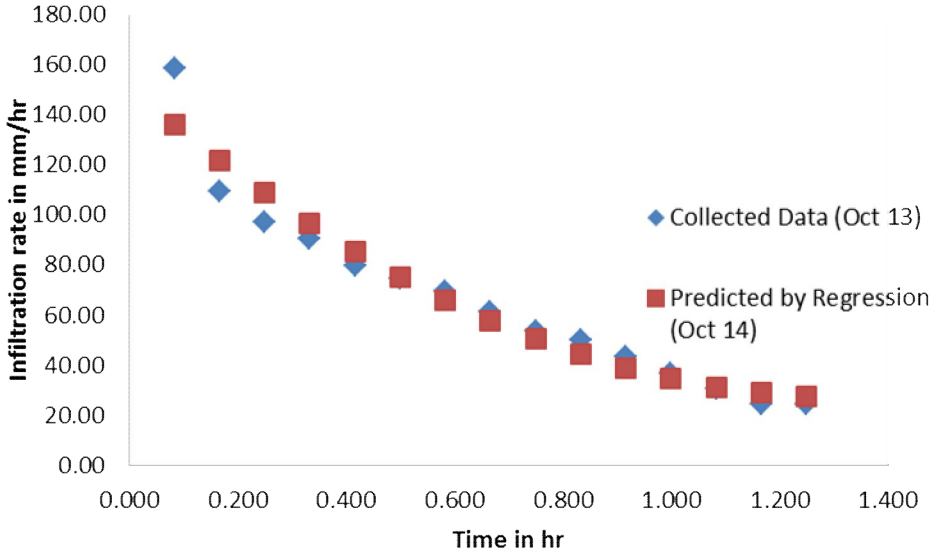

Figure 5.6 Infiltration Rate vs Time of Garden 15-45 Ring (Annular) for the Month of October

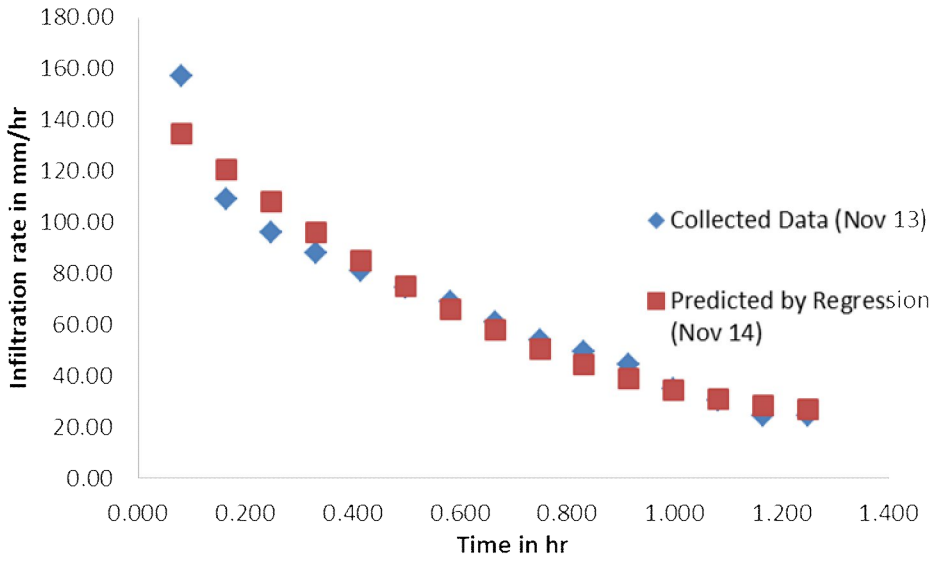

Figure 5.7 Infiltration Rate vs Time of Garden 15-45 Ring (Annular) for the Month of November

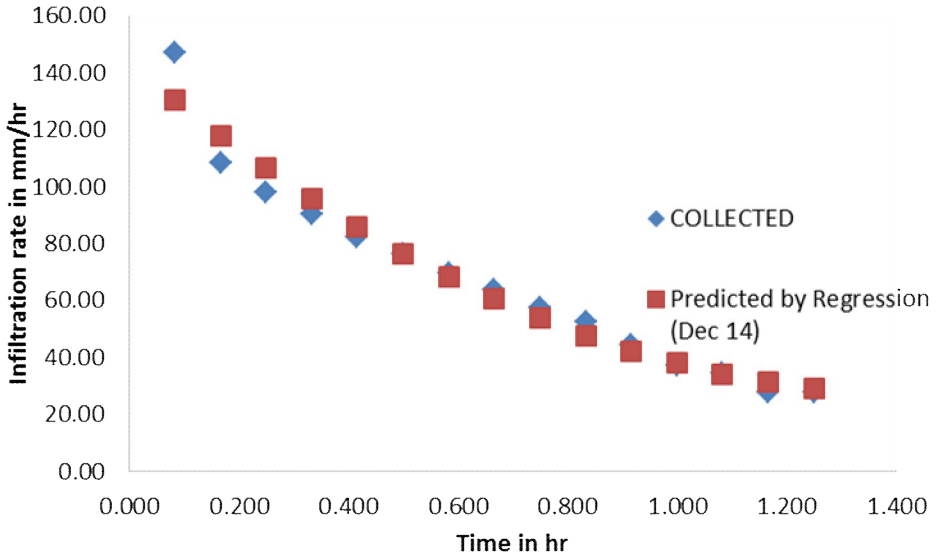

Figure 5.8 Infiltration Rate vs Time of Garden 15-45 Ring (Annular) for the Month of December

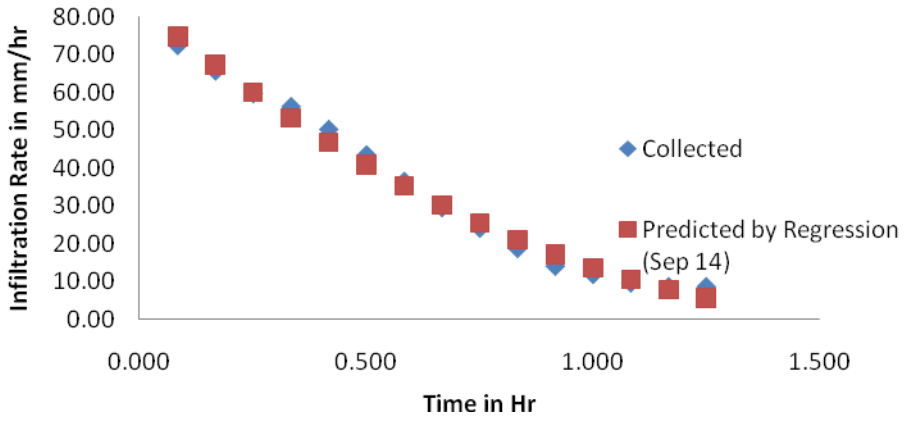

Figure 5.9 Infiltration Rate vs Time of Garden 30-60 Ring (Inner) for the Month of September

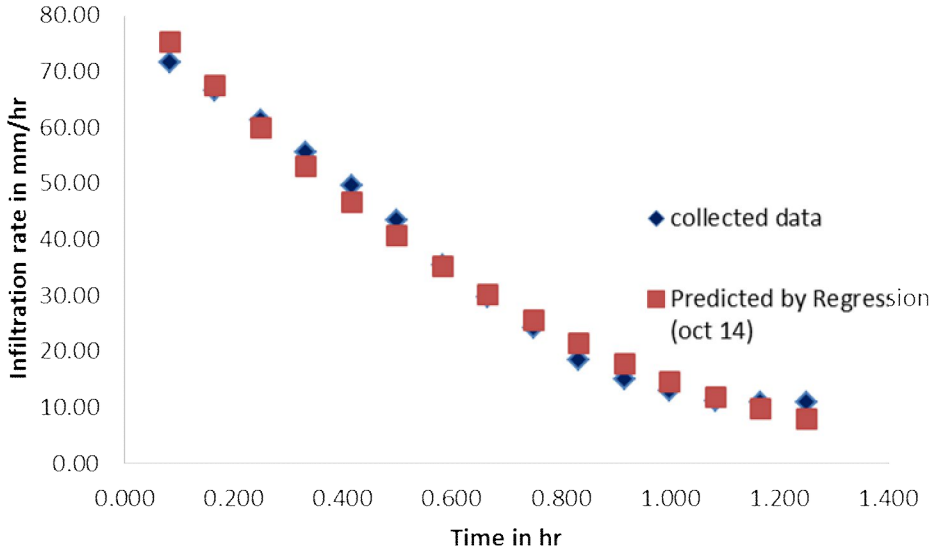

Figure 5.10 Infiltration Rate vs Time of Garden 30-60 Ring (Inner) for the Month of October

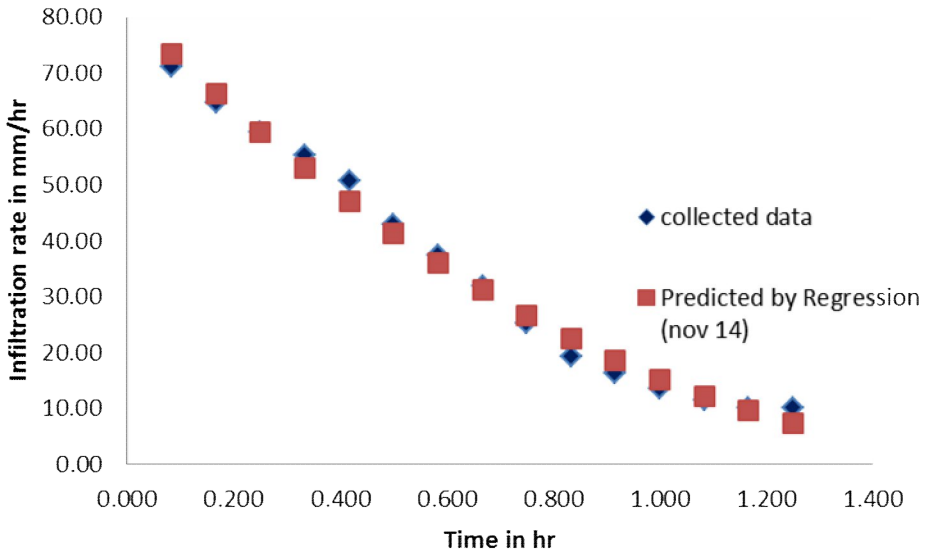

Figure 5.11 Infiltration Rate vs Time of Garden 30-60 Ring (Inner) for the Month of November

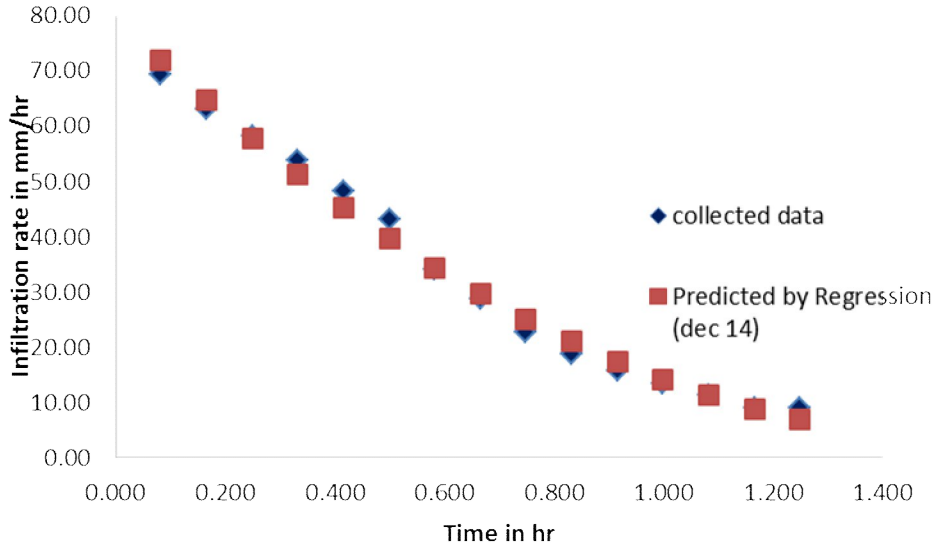

Figure 5.12 Infiltration Rate vs Time of Garden 30-60 Ring (Inner) for the Month of December

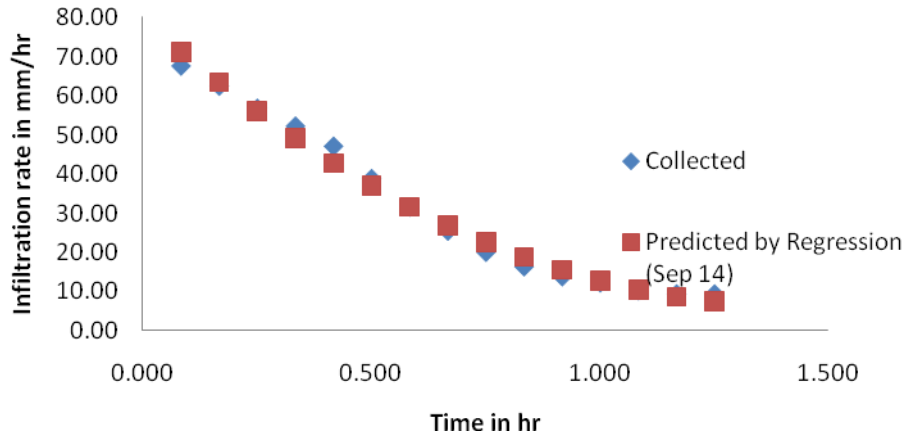

Figure 5.13 Infiltration Rate vs Time of Garden 30-60 Ring (Annular) for the Month of September

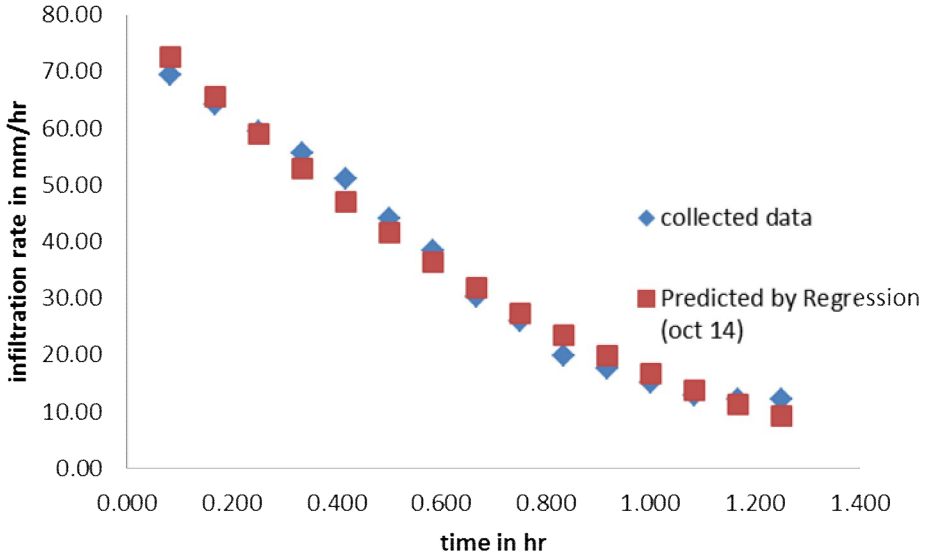

Figure 5.14 Infiltration Rate vs Time of Garden 30-60 Ring (Annular) for the Month of October

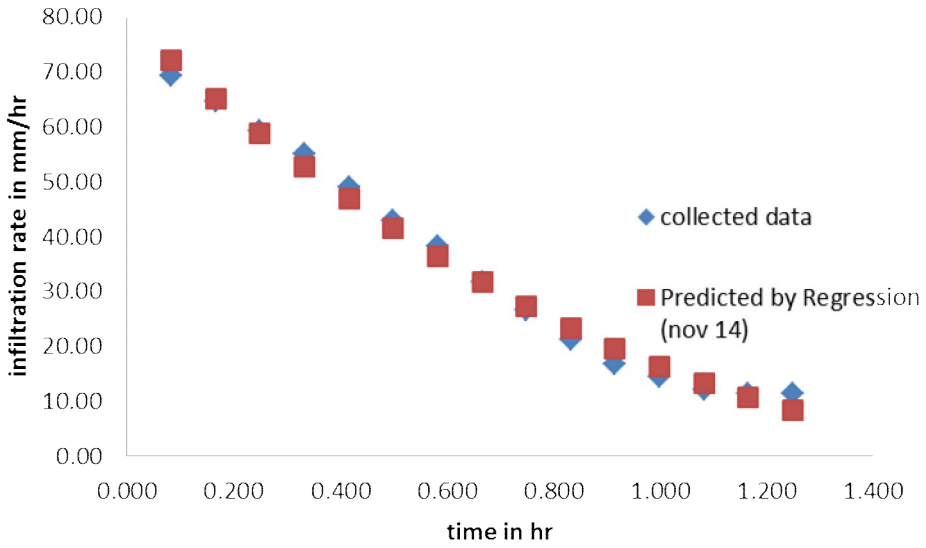

Figure 5.15 Infiltration Rate vs Time of Garden 30-60 Ring (Annular) for the Month of November

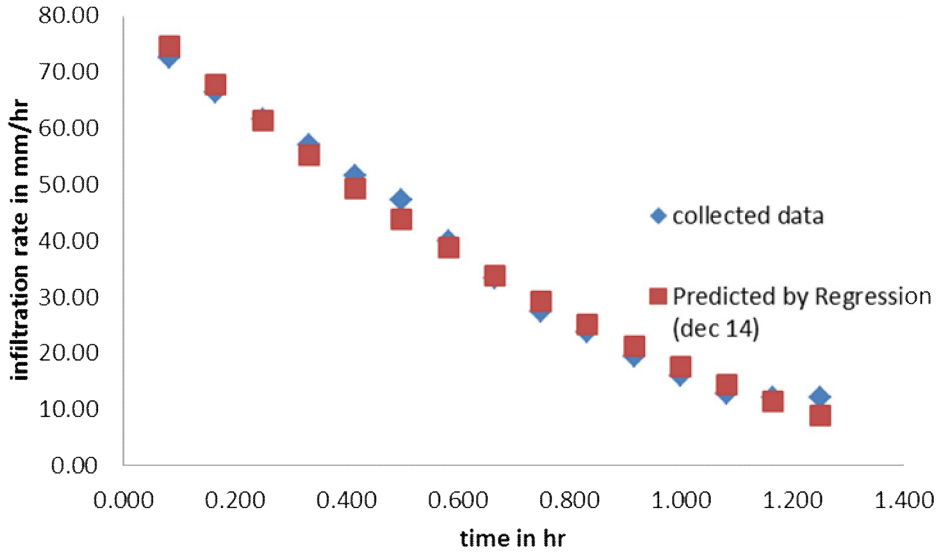

Figure 5.16 Infiltration Rate vs Time of Garden 30-60 Ring (Annular) for the Month of December

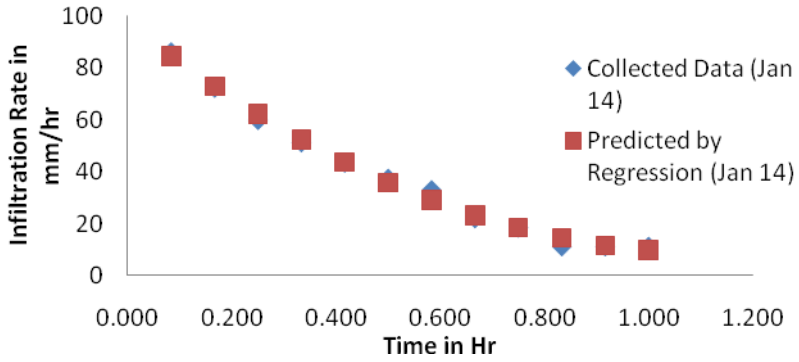

Figure 5.17 Infiltration Rate vs Time of Forest 15-45 Ring (Inner) for the Month of January

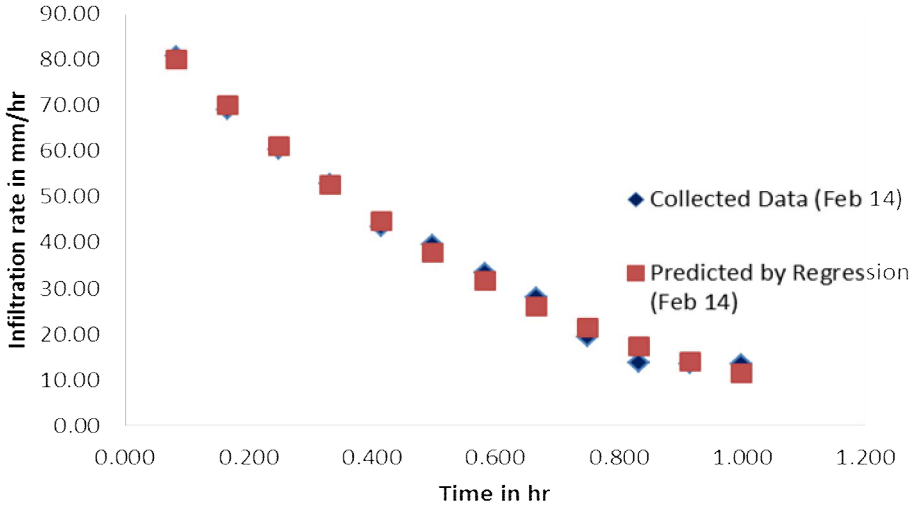

Figure 5.17 Infiltration Rate vs Time of Forest 15-45 Ring (Inner) for the Month of Febuary

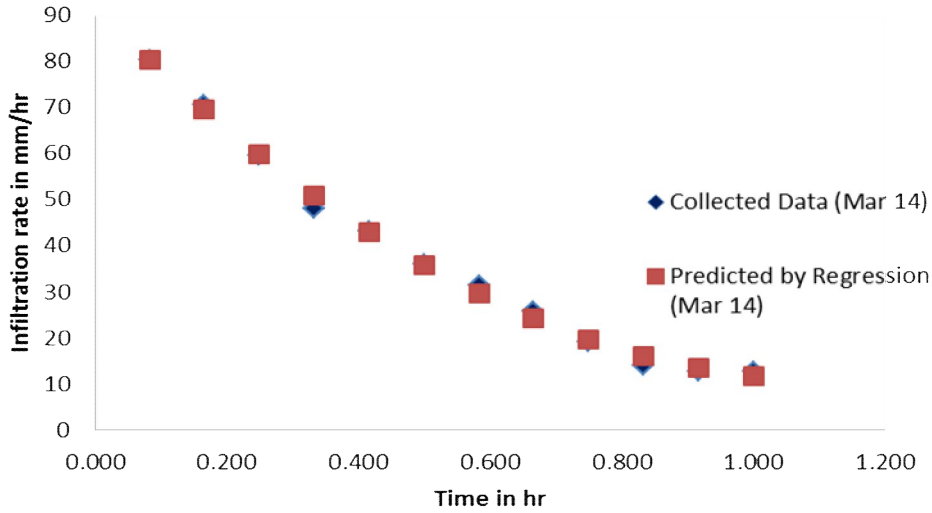

Figure 5.18 Infiltration Rate vs Time of Forest 15-45 Ring (Inner) for the Month of March

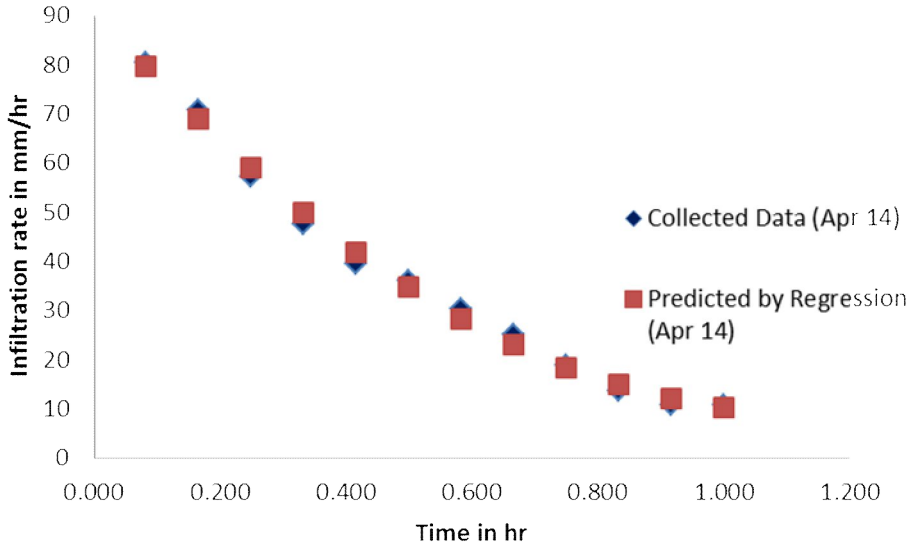

Figure 5.19 Infiltration Rate vs Time of Forest 15-45 Ring (Inner) for the Month of April

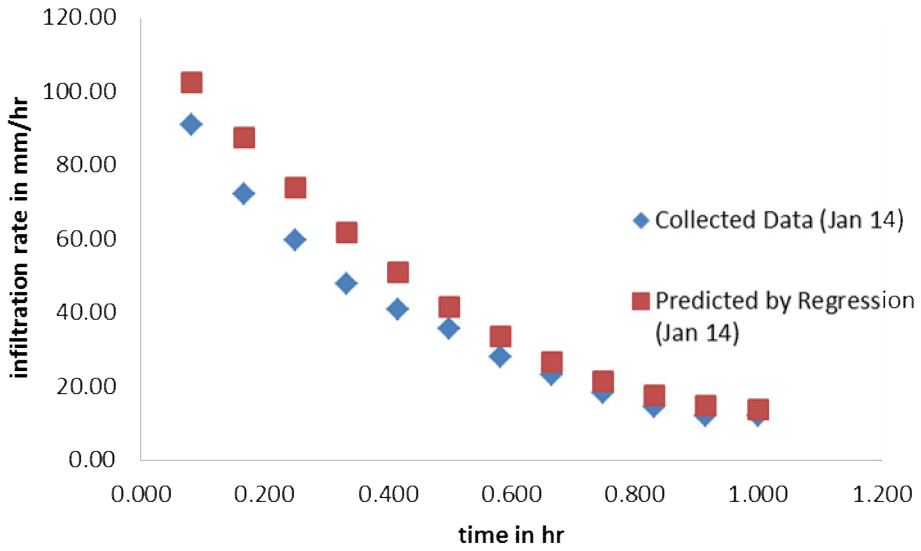

Figure 5.20 Infiltration Rate vs Time of Forest 15-45 Ring (Annular) for the Month of January

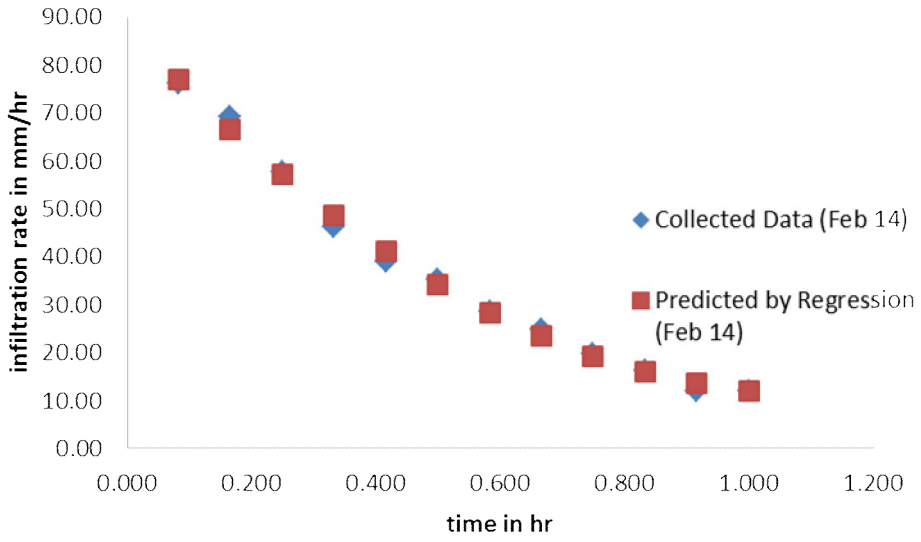

Figure 5.21 Infiltration Rate vs Time of Forest 15-45 Ring (Annular) for the Month of Febuary

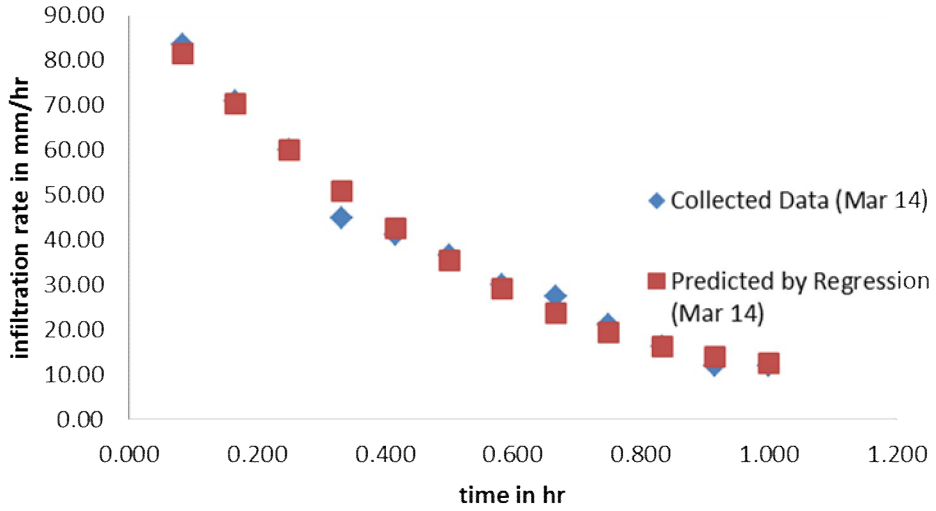

Figure 5.22 Infiltration Rate vs Time of Forest 15-45 Ring (Annular) for the Month of March

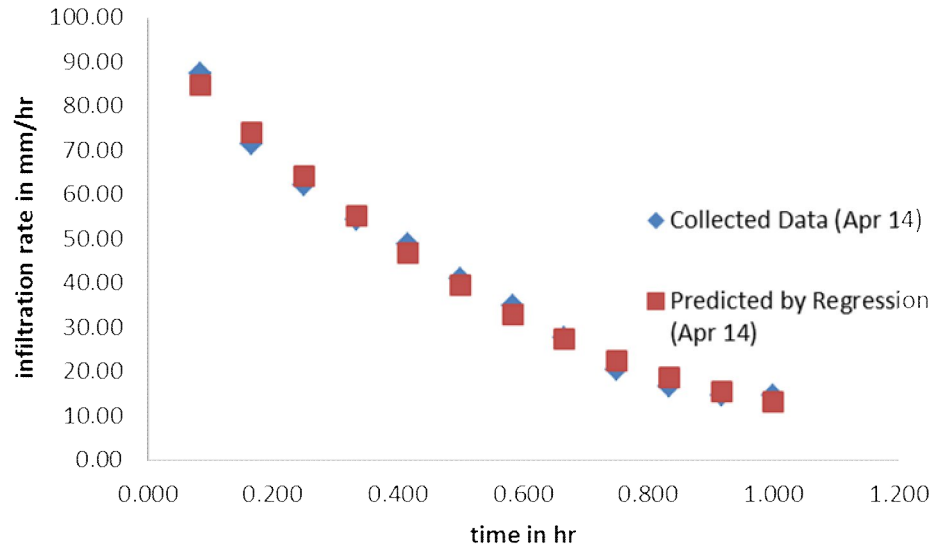

Figure 5.23 Infiltration Rate vs Time of Forest 15-45 Ring (Annular) for the Month of April

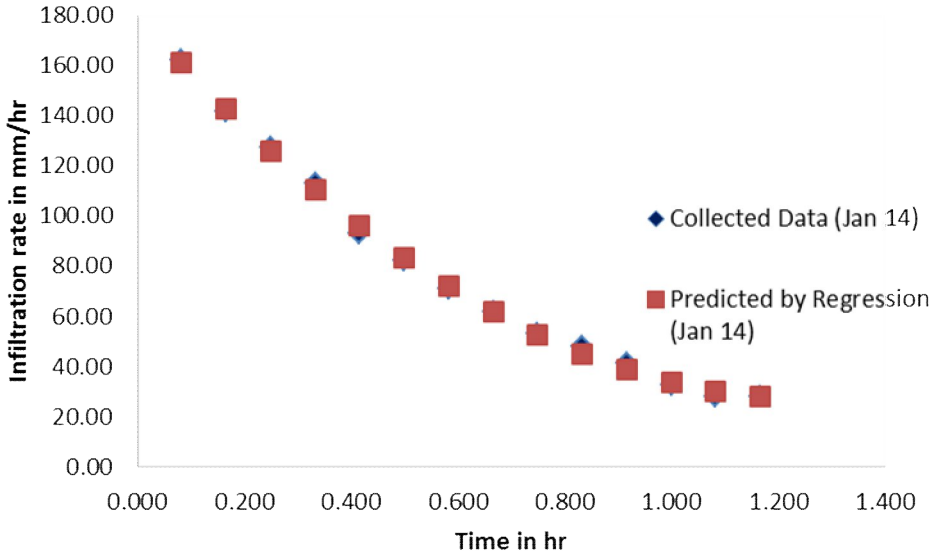

Figure 5.24 Infiltration Rate vs Time of Forest 30-60 Ring (Inner) for the Month of January

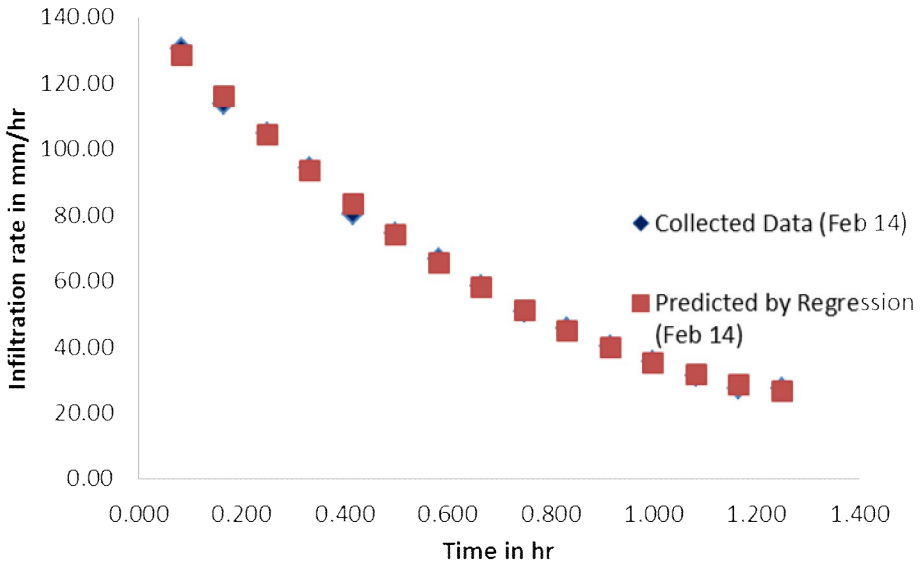

Figure 5.25 Infiltration Rate vs Time of Forest 30-60 Ring (Inner) for the Month of Febuary

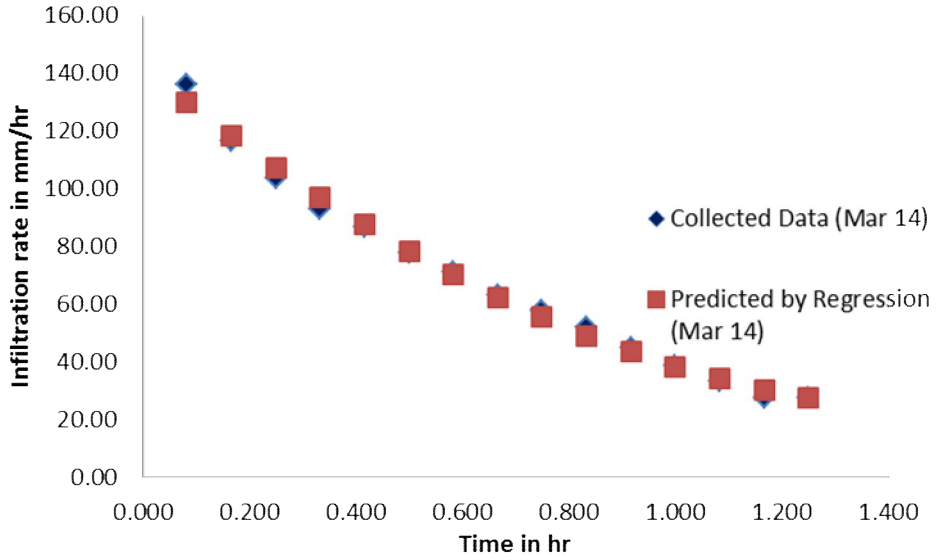

Figure 5.26 Infiltration Rate vs Time of Forest 30-60 Ring (Inner) for the Month of March

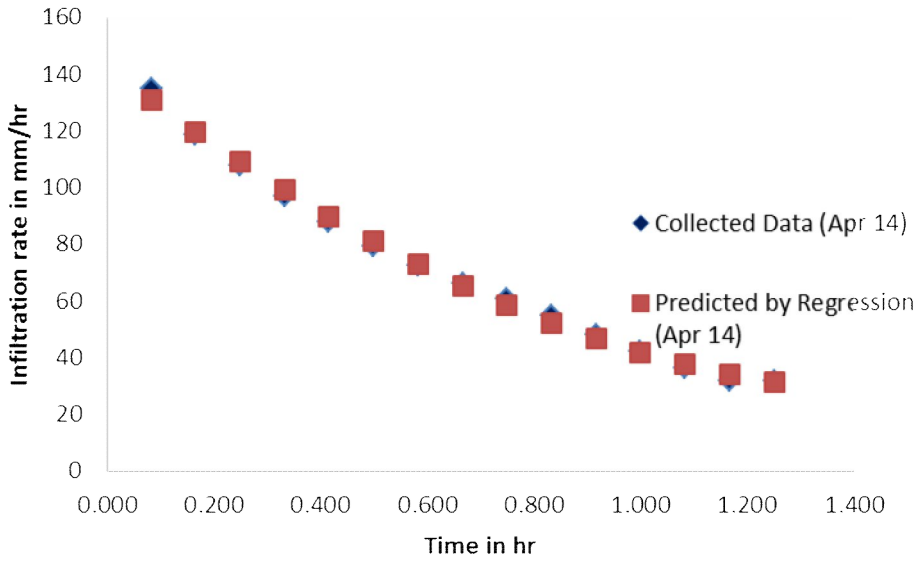

Figure 5.27 Infiltration Rate vs Time of Forest 30-60 Ring (Inner) for the Month of April

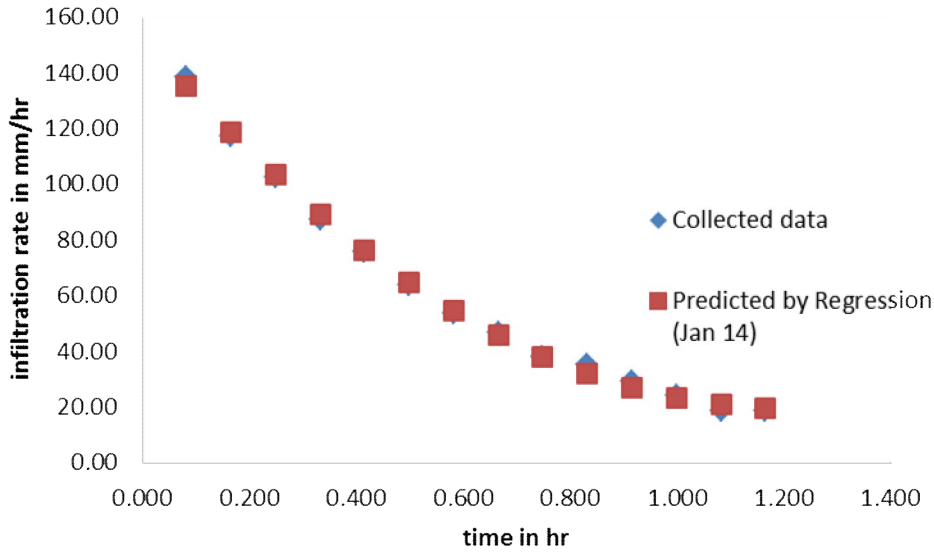

Figure 5.28 Infiltration Rate vs Time of Forest 30-60 Ring (Annular) for the Month of January

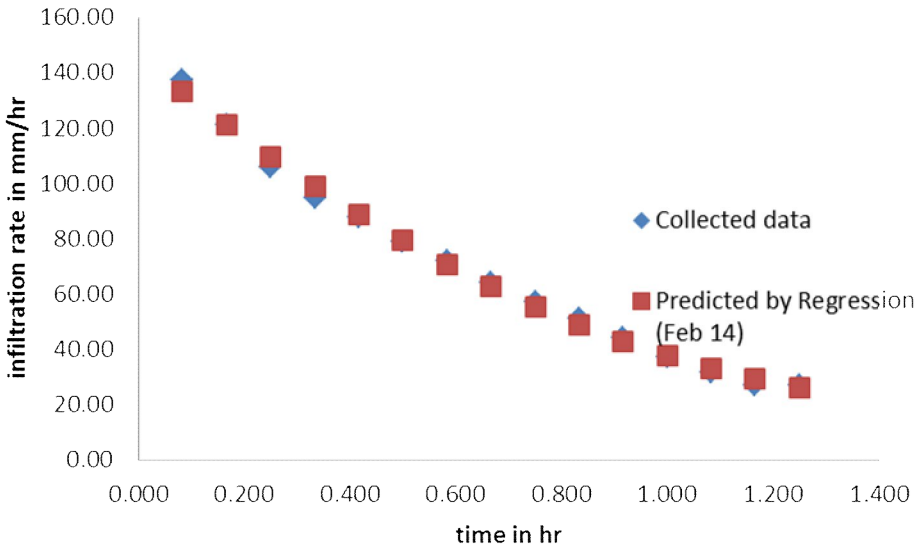

Figure 5.29 Infiltration Rate vs Time of Forest 30-60 Ring (Annular) for the Month of Febuary

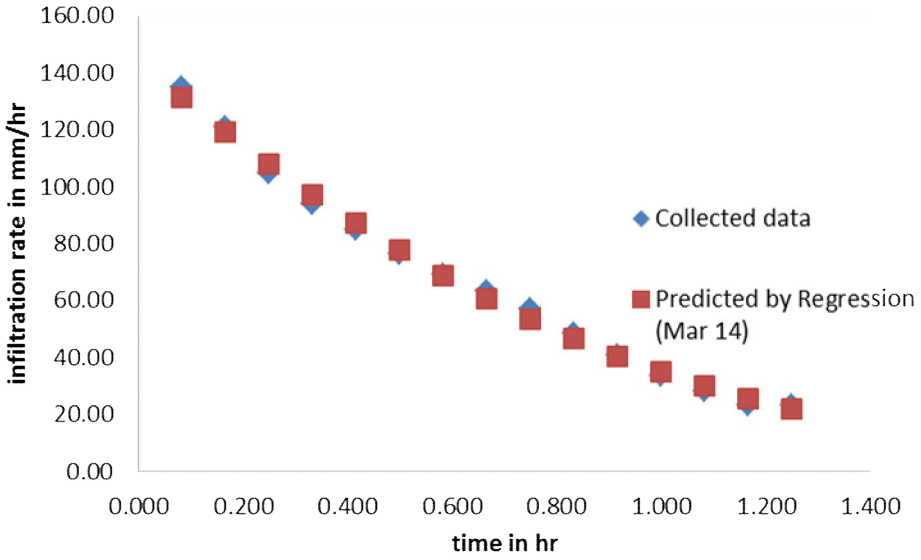

Figure 5.30 Infiltration Rate vs Time of Forest 30-60 Ring (Annular) for the Month of March

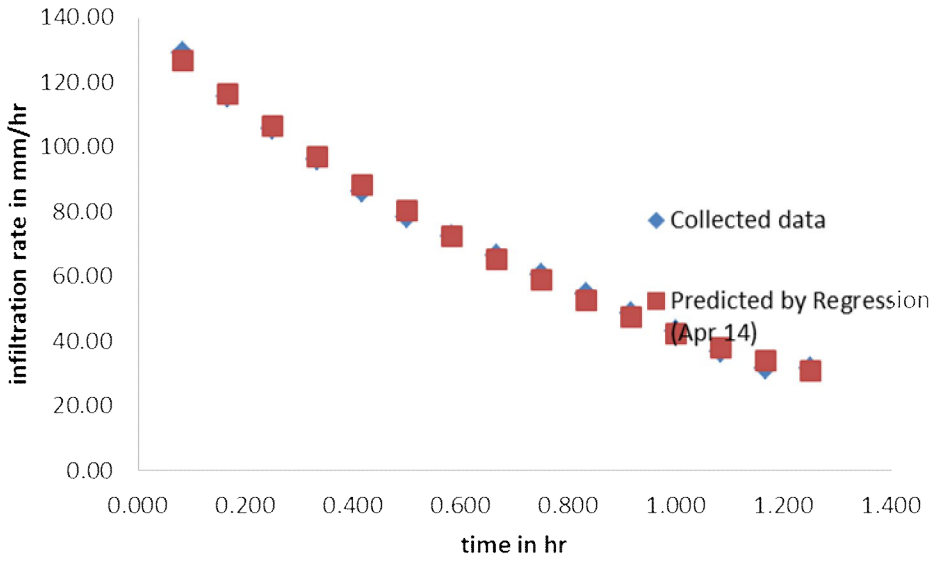

Figure 5.31 Infiltration Rate vs Time of Forest 30-60 Ring (Annular) for the Month of April

The regression values (R^2) are given in table as follows:

Table 5.1: Regression Values for Garden 15-45 Rings

Garden 15-45 Inner Data			
Sl No.	Month	R2 of Collected Data	R2 of Predicted Data by Regression
1	Sep-14	0.933	1
2	Oct-14	0.935	1
3	Nov-14	0.953	1
4	Dec-14	0.954	1
Garden 15-45 Annular Data			
1	Sep-14	0.924	1
2	Oct-14	0.947	1
3	Nov-14	0.935	1
4	Dec-14	0.962	1

Table 5.2: Regression Values for Forest 30-60 Rings

Forest 30-60 Inner Data			
Sl No.	Month	R2 of Collected Data	R2 of Predicted Data by Regression
1	Jan-14	0.9984	1
2	Feb-14	0.9985	1

3	Mar-14	0.9937	1
4	Apr-14	0.9967	0.9967
Forest 30-60 Annular Data			
1	Jan-14	0.9977	1
2	Feb-14	0.9959	1
3	Mar-14	0.9956	1
4	Apr-14	0.9975	1

Table 5.3 Regression Values for Garden 30-60 Rings

GARDEN 30-60 Inner Data			
Sl No.	Month	R2 of Collected Data	R2 of Predicted Data by Regression
1	14-Sep	0.9906	1
2	14-Oct	0.9896	1
3	14-Nov	0.9905	1
4	14-Dec	0.9912	1
GARDEN 30-60 Annular Data			
1	14-Sep	0.9891	1
2	14-Oct	0.9865	1
3	14-Nov	0.9912	1
4	14-Dec	0.9917	1

Table 5.4Regression Values for Forest 15-45 Rings

Forest 15-45 Inner Data			
Sl No.	Month	R2 of Collected Data	R2 of Predicted Data by Regression
1	Jan-14	0.993	1
2	Feb-14	0.993	1
3	Mar-14	0.996	1
4	Apr-14	0.994	1
Forest 15-45 Annular Data			
1	Jan-14	0.993	1
2	Feb-14	0.995	1
3	Mar-14	0.989	1
4	Apr-14	0.994	1

5.3 Horton's Equation

The values of infiltration capacity calculated by the Horton's Equation are given in the table as follows:

Table5.5. Values of Infiltration Capacity from Horton's Equation

	K
15-45 garden inner	0.50
15-45 garden annular	0.50
30-60 garden inner	0.50
30-60 garden annular	0.50
15-45 forest inner	0.42
15-45 forest annular	0.43
30-60 forest inner	0.43
30-60 forest annular	0.42

5.4 Incremental Infiltration Rate

As per discussed in the methodology, the incremental infiltration rate are calculated and the graphs are as shown below:

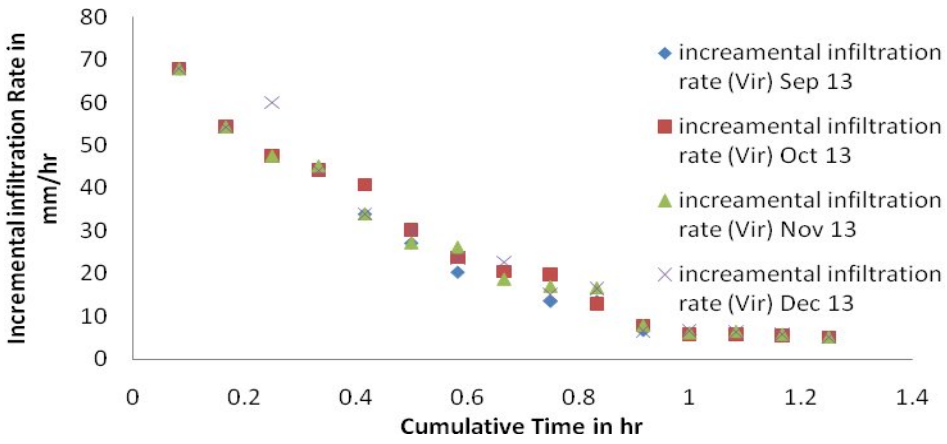

Figure 5.32 Incremental Infiltration Rate vs Cumulative time of Garden 15-45 Ring (Annular)

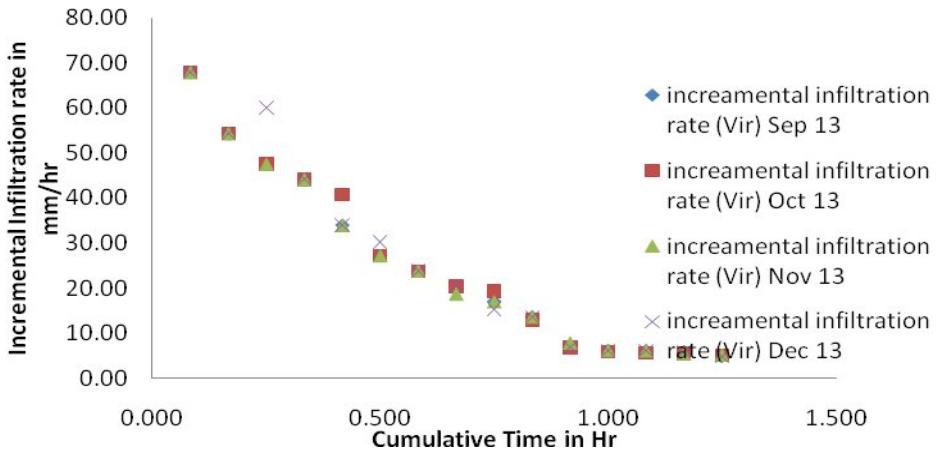

Figure 5.33 Incremental Infiltration Rate vs Cumulative time of Garden 15-45 Ring (Inner)

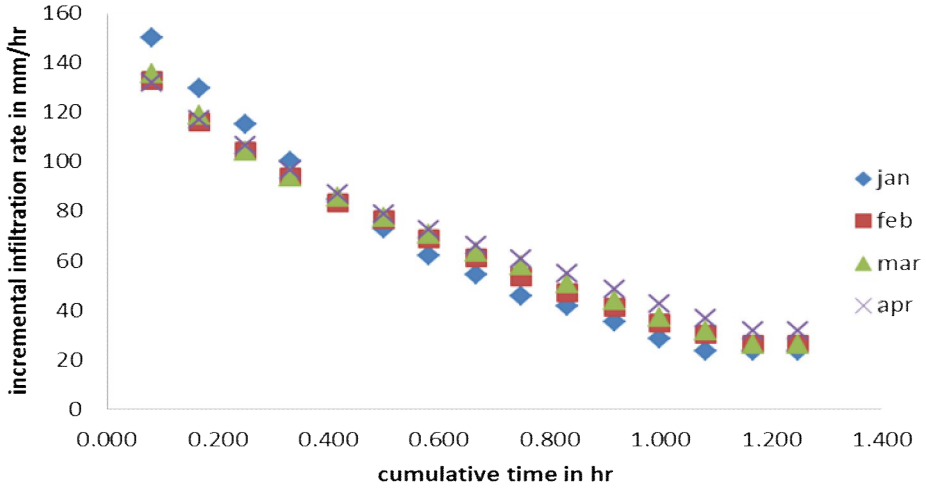

Figure 5.34 Incremental Infiltration Rate vs Cumulative time of Forect 15-45 Ring (Annular)

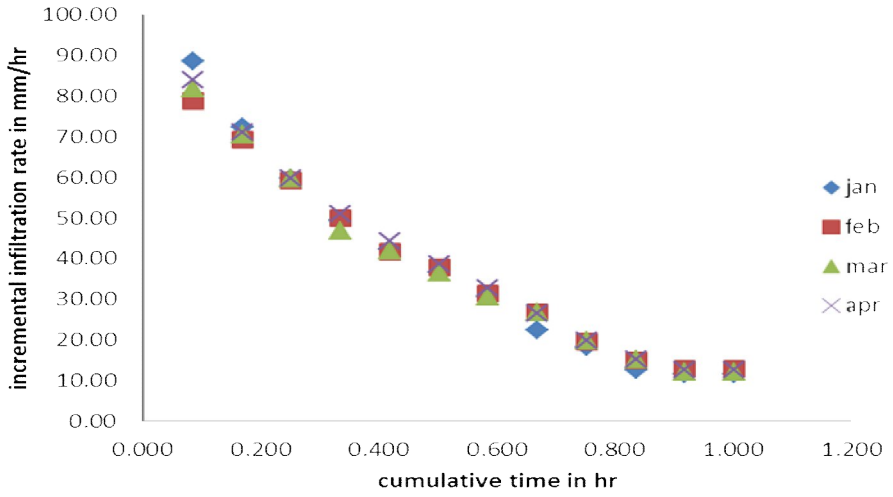

Figure 5.35 Incremental Infiltration Rate vs Cumulative time of Forest 15-45 Ring (Inner)

5.5 Artificial Neural Network (ANN)

The data in neural networks are categorized into two sets; training or learning sets, and test or over fitting test sets. The learning set is used to determine the adjusted weights and biases of a network. The test set is used for calibration, which prevents over training networks. The over fitting test set consists of a representative data set. It is important to divide the data set in such a way that both training and over fitting test data sets are statistically comparable. The 70% of data are used for validation and training i.e. each of 35% and 30% of the data are used for testing. The prediction by ANN determines the input vector to the network by two algorithms; those are back propagation network (BPN) and radial basis function (RBF). The input normalised data of water quality in the network algorithm are continued with adding one more data in the network input layer and the performance of input layer is examined on the basis of statistical indices i.e. goodness of fit statistics. As the number of hidden layer in network algorithm of the model is increased or decreased, there is a change in goodness of fit statistics. So it is clear that, the goodness of fit statistics had been done for training, validation and testing of time series data with fixing the hidden layers to 10 during modelling process. The target values are iterated by the model after the target time steps given. Simultaneously, the autocorrelation, input-output correlation and

error correlation are calculated by the model. Root mean squared error (RMSE) is the error between output and given target values by the model. Here, R is the measure of regression between output and target data. The regression graphs of the forest and garden area are as follows:

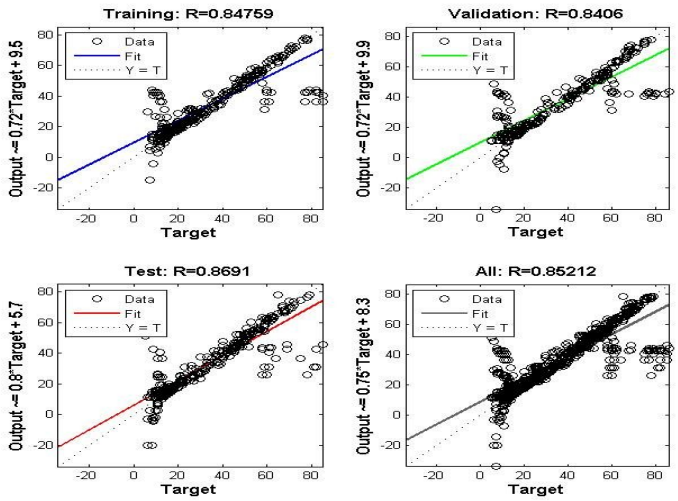

Figure 5.36 Regression Graph for Garden 15-45 Ring (Inner)

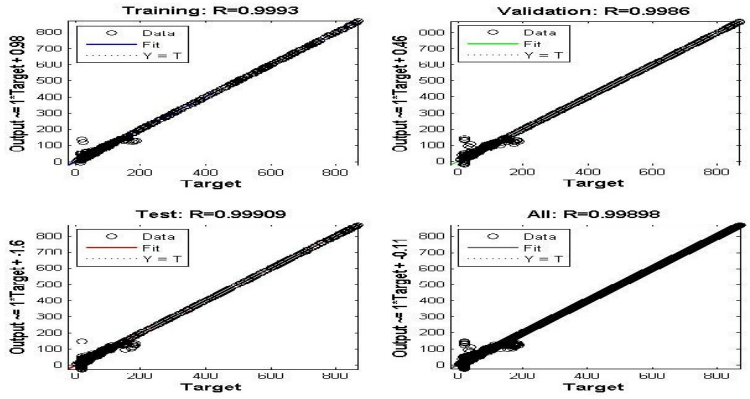

Figure 5.37 Regression Graph for Garden 15-45 Ring (Annular)

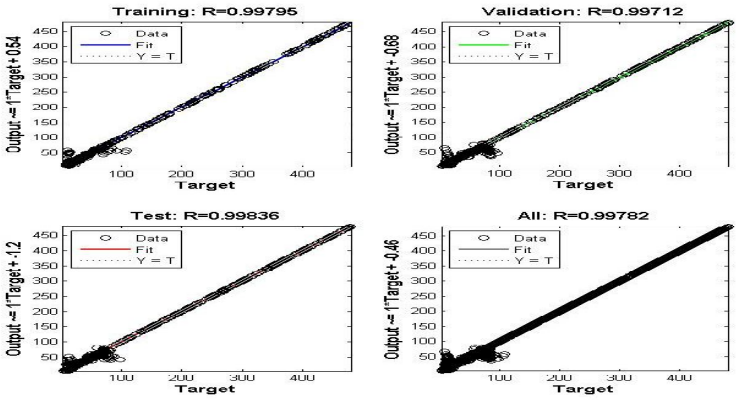

Figure 5.38 Regression Graph for Forest 30-60 Ring (Inner)

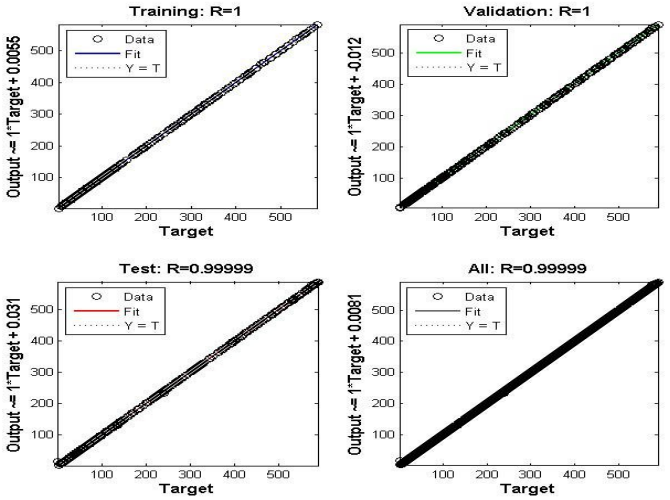

Figure 5.39 Regression Graph for Forest 30-60 Ring (Annular)

The predicted values along with the graph are as shown below:

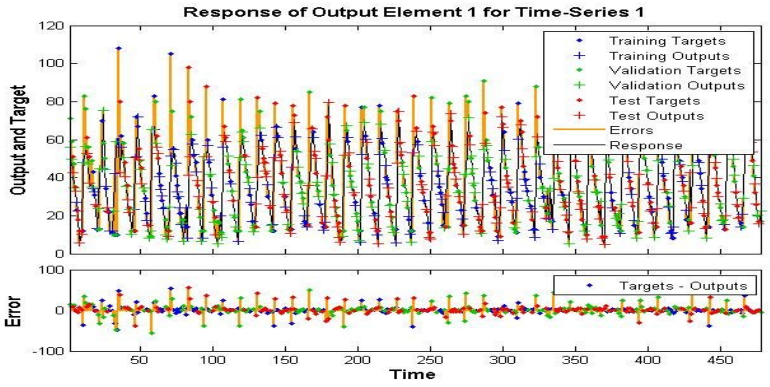

Figure 5.40 Response Output Graph for Forest 30-60 Ring (Inner)

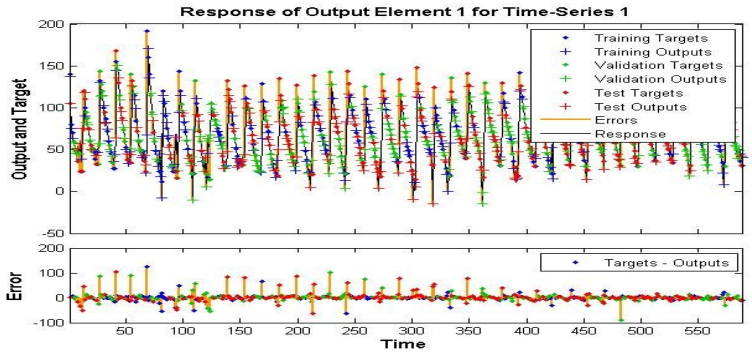

Figure 5.41 Response Output Graph for Forest 30-60 Ring (Annular)

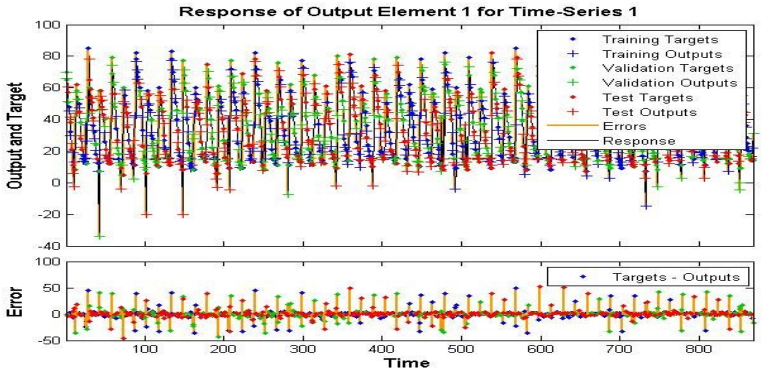

Figure 5.41Response Output Graph for garden15-45 Ring (Inner)

The table shows the regression values of the predicted data by ANN as shown below:

Table 5.6 Regression Values extracted by ANN

Forest 15-45 Inner Data			
Sl No.	Month	R2 of Collected Data	R2 of Predicted Data by Regression
1	Jan-14	0.993	0.9917
2	Feb-14	0.993	0.9927
3	Mar-14	0.996	0.9966
4	Apr-14	0.994	0.9936
Forest 15-45 Annular Data			
1	Jan-14	0.993	0.9866
2	Feb-14	0.995	0.9952
3	Mar-14	0.989	0.9903
4	Apr-14	0.994	0.9964

Forest 30-60 Inner Data			
Sl No.	Month	R2 of Collected Data	R2 of Collected Data
1	14-Jan	0.9987	0.9987
2	14-Feb	0.998	0.998
3	14-Mar	0.9939	0.9939
4	14-Apr	0.9978	0.9978
Forest 30-60 Annular Data			
1	14-Jan	0.9978	0.9978
2	14-Feb	0.9964	0.9964
3	14-Mar	0.9956	0.9956
4	14-Apr	0.9968	0.9968

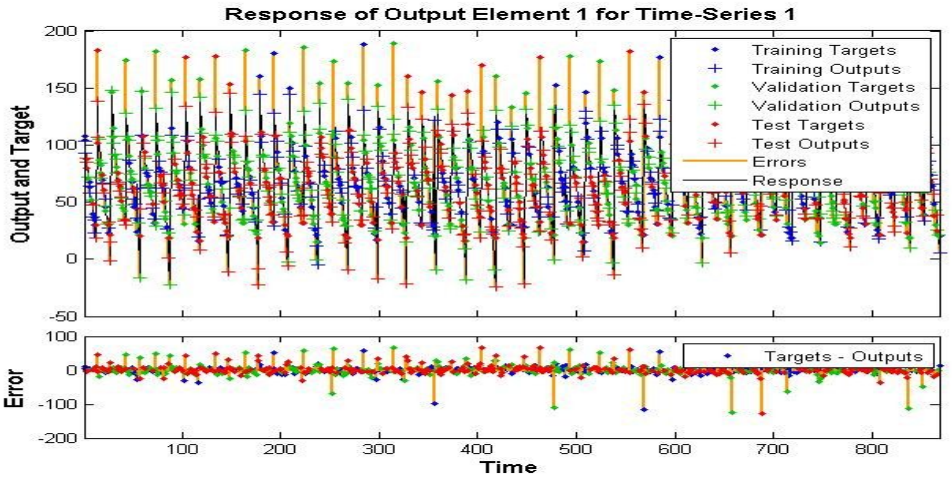

Figure 5.42 Response Output Graph for Garden15-45 Ring (Annular)

5.6 Error analysis

The tables of 15-45 and 30-60 cm double ring showing MAE and MAPE are given below:

Table 5.7 Error analysis of Garden 15-45 ring

Garden 15-45 Inner				
	MAE (Collected and Regression)	MAE (Collected and ANN)	MAPE (Collected and Regression)	MAPE (Collected and ANN)
Sep-14	6.81	7.36	0.09	0.10
Oct-14	6.68	11.02	0.09	0.20
Nov-14	5.44	8.34	0.08	0.14
Dec-14	5.62	8.86	0.08	0.11
Garden 15-45 Annular				
	MAE (Collected and Regression)	MAE (Collected and ANN)	MAPE (Collected and Regression)	MAPE (Collected and ANN)
Sep-14	7.13	6.92	0.10	0.09
Oct-14	5.93	5.93	0.08	0.08
Nov-14	5.60	5.59	0.08	0.08
Dec-14	6.37	4.30	0.06	0.05

Table Table 5.8 Error analysis of Forest 15-45 ring

Forest 15-45 Inner				
	MAE (Collected and Regression)	MAE (Collected and ANN)	MAPE (Collected and Regression)	MAPE (Collected and ANN)
Jan-14	1.47	1.47	0.06	0.03
Feb-14	1.51	0.89	0.07	0.02
Mar-14	1.03	0.76	0.04	0.03
Apr-14	1.53	1.03	0.05	0.04
Forest 15-45 Annular				
	MAE (Collected and Regression)	MAE (Collected and ANN)	MAPE (Collected and Regression)	MAPE (Collected and ANN)
Jan-14	7.43	2.72	0.22	0.11
Feb-14	2.92	3.83	0.08	0.12
Mar-14	1.15	1.62	0.04	0.06
Apr-14	4.45	4.53	0.17	0.16

CHAPTER 6

CONCLUSIONS

The conclusions from the above research work are as follows:

- As the measurements were taken in NIT field and water was spread for plants in regular interval. So, the infiltration to the soil got constant after a short time interval due to saturation of the soil.
- The infiltration rate and incremental infiltration rate values are approximately equal, which shows the rate of infiltration is equal in both of the methods applied.
- The MAE and MAPE are calculated by the given formulas for Collected data, Predicted data by regression analysis and predicted data by ANN. The errors in case of Collected data verses regression analysis data are less than the predicted data by ANN.
- The permeability and soil water content & were 1.369×10^(-4) and 16.128%.
- Finally it can be concluded that the 30-60 double ring infiltro-meter can give better performance than double ring infiltro-meter of 15cm - 30cm. The garden oil infiltrated more rapidly than the forest soil due to having more hydraulic conductivity values as calculated by Horton's equation.
- The soil has more conductivity values in the months of September and October than that of other months.
- The natural soil had a high infiltration rate compared to the other fields due to the deep cracks in the soil and the low initial water content.

CHAPTER 7

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