CS-105

# INFILTRATION STUDIES IN THE MALAPRABHA AND GHATAPRABHA CATCHMENTS

NATIONAL INSTITUTE OF HYDROLOGY
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## PREFACE

The process of infiltration has a special significance in hydrologic study as the understanding of the same may enable us to estimate more effectively the amounts of runoff originating from precipitation , and the results thereof can be applied more confidently to the design problems. Further , the soil water component of the watershed system involves infiltration , soil moisture storage, percolation, and ET. Infiltration is thus require in simulating the response of this component. It is required in solution of a myriad of hydrologic problems. It may very well be one of the most important and is certainly one of the most complex element of the hydrologic cycle. Therefore, the precise , quantitative determination and understanding of the mechanism constituting the process form an important part of the studies on Rainfall-Runoff relations , soil conservation and management , ground water availability and water allocation and utilization.

Keeping in view of the above importance of the infiltration study the regional centre has planned to observe the infiltration rates for the whole hard rock region. As a part of the programme , the present study has been carried out in the Representative basins , viz., in Malaprabha (upto Khanapur) and Ghataprabha (upto Daddi) catchments. The present study includes a strategy for conducting infiltration test under complex geographical environment (i.e., soil, rocks , landuse pattern) and defines the pattern of spatial variability of the infiltration rates in the representative basins (viz., Malaprabha and Ghataaprabha) of the hard rock region of India.

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# 1.0 INTRODUCTION

## 1.1 The concept of infiltration

When rain water continues to fall beyond the limits of interception and reaches the soil surface, it enters the soil. This process is known as infiltration. The term of infiltration was used by Marsh in 1864 in his book " Man and Nature". In 1921 Ivan Honk reported some results of measurements of infiltration under varying condition in the vicinity of the Miami river. In mid 1930's, a research committee was established by American geophysical Union. Later on the concept of infiltration was further developed by Horton (1931, 1933,938,1945) and the infiltration theory of surface runoff developed.

The infiltration theory of surface runoff is based on two fundamental concepts. These are;

1) There is a maximum limiting rate at which the soil when in a given condition can absorb rain as it falls. This is infitration capacity.

2) When runoff takes place from any soil surface, large or small, there is a definite funtional relation between the depth of surface detention or the quantity of water which accumulates on the soil surface and the rate of surface runoff or channel inflow.

Infiltration capacity is goverened by physical laws and process which involve the simultaneous downward flow of water and the upward flow of displaced air through the same system of sol pores and is used in the sense of a limiting rate of flow, like capacity of a water pipe.

The infiltration capacity of a given area is not usually constant during rain but, starting with an initial value, it decreases rapidly at first, then after about half an hour to 2 or 3 hours attains a constant value which is known as constant rate of infiltration.

## 1.2 Application

Infiltration has an important place in the hydrological cycle. Detailed study of infiltration process helps Planners, hydrologists, farmers and decision makers in number of ways, because the knowledge of infiltration capacity helps in the;

1) estimation of peak rates and volumes of runoff in planning of dams, culverts and bridges etc.
2) estimation of surface runoff and overland flow;
3) planning of watershed engineering;
4) estimation of ground water recharge;
5) assesment of soil moisture deficits and planning irrigation and drainage system etc.

## 1.3 Objectives

In view of the above applications of the infiltration process , it is proposed to define this process in the representative basins , vis., Malaprabha and Ghataprabha (Fig 1) of the hard rock region. The fundamental objectives of the study are:

1) to define the spatial variability in the infiltration capacity;
2) to define the control ofsoil in the infiltration capacity;
3) to define the control of landuse pattern in infiltration capacity.

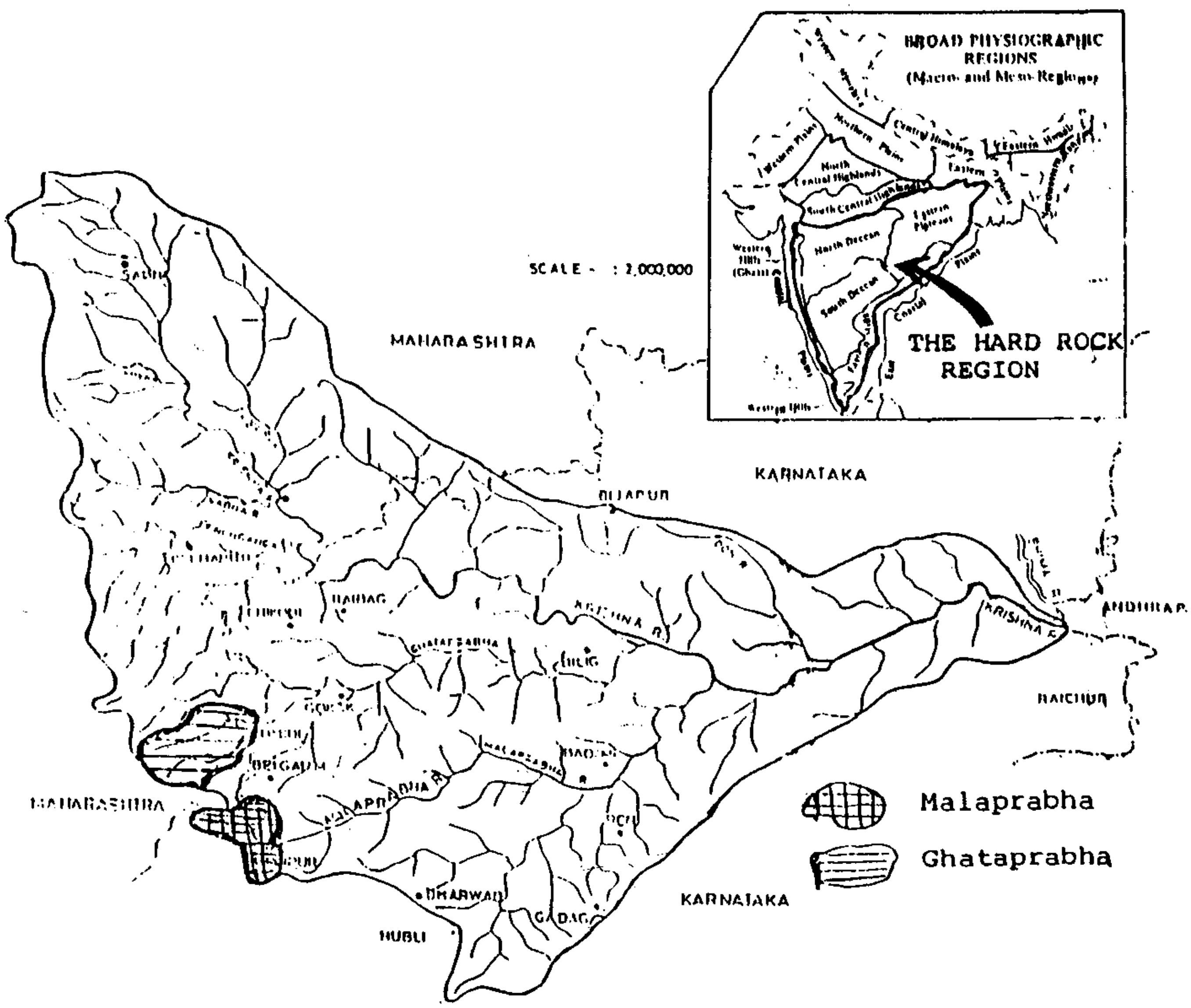



Fig.1 Location Map of the Malaprabha and Ghataprabha Representative Basin.

## 2.0 ABOUT THE STUDY AREAS

### 2.1 The Malaprabha Representative Basin

2.1.1 Location:- The Malaprabha representative basin lies in the extream western part of the Krishna basin (Fig. 1). It extends between 70 8′ and 74 30′ E longitudes, and 15 30′ and 15 40′ N latitudes. It encompasses an area of about 540 sq km of the Belgaum district in the Karnataka state.

2.1.2 Geology:- Geologicaly the Malaprabha representative basin comprises of two main geological formations (NWDA,1990). These are (Fig 2);

1) Tertiary basalt and

2) Sedimentary formation of Pre-Cambrian age

Table 1 contains the area under these geological formations which reveals that a major part (96%) of the study area is covered by tertiary basalt. The sedimentary formation of Pre-Cambrian age includes only about (4%) are in the south eastern part of the basin.

2.1.3 Soils:- Pedologically, the study area is divisible in to two different types of soil groups. These are (Fig 3);

1) red loamy soil and

2) medium black soil

Table 1: Distribution of area under different rock formations in the Malaprabha representative basin

| | Rock formation | Area in sq.km | Area in % |
|---|---|---|---|
| 1 | Tertiary Basalts | 518.4 | 96.0 |
| 2. | Sedimentary rocks | 21.6 | 4.0 |
| | | 540.00 | 100.00 |

Table 2: Distribution of area under different soil groups in the Malaprabha representative basin

| | Soil groups | Area in sq.km | Area in % |
|---|---|---|---|
| 1. | Red loamy soil | 432.0 | 80.0 |
| 2. | Medium black soil | 108.0 | 20.0 |
| | Total | 540.00 | 100.00 |

Table 3: Distribution of area under different land use type in the Malaprabha representative basin

| Sl.No | Land use type | Area in sq.km | Area in % |
|---|---|---|---|
| 1. | Forests | 338.58 | 62.65 |
| 2. | Shrubs | 104.22 | 19.30 |
| 3 | Agriculture | 90.99 | 16.85 |
| 4. | Barren | 6.21 | 1.15 |
| | Total | 540.0 | 100.0 |

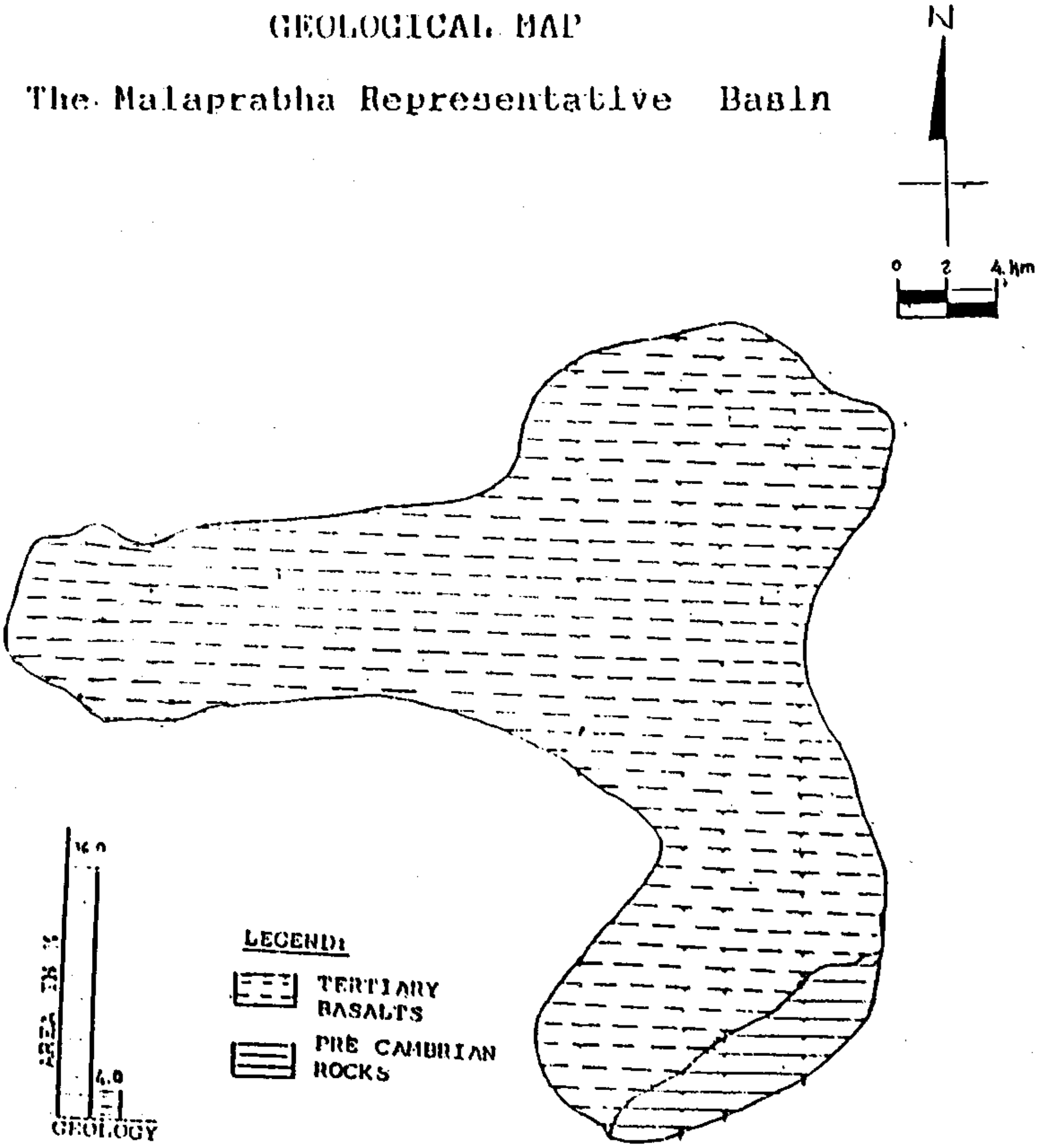



**Fig.2 Geological Map of the Malaprabha Representative Basin.**

## SOIL MAP

## The Malaprabha Representative Basin

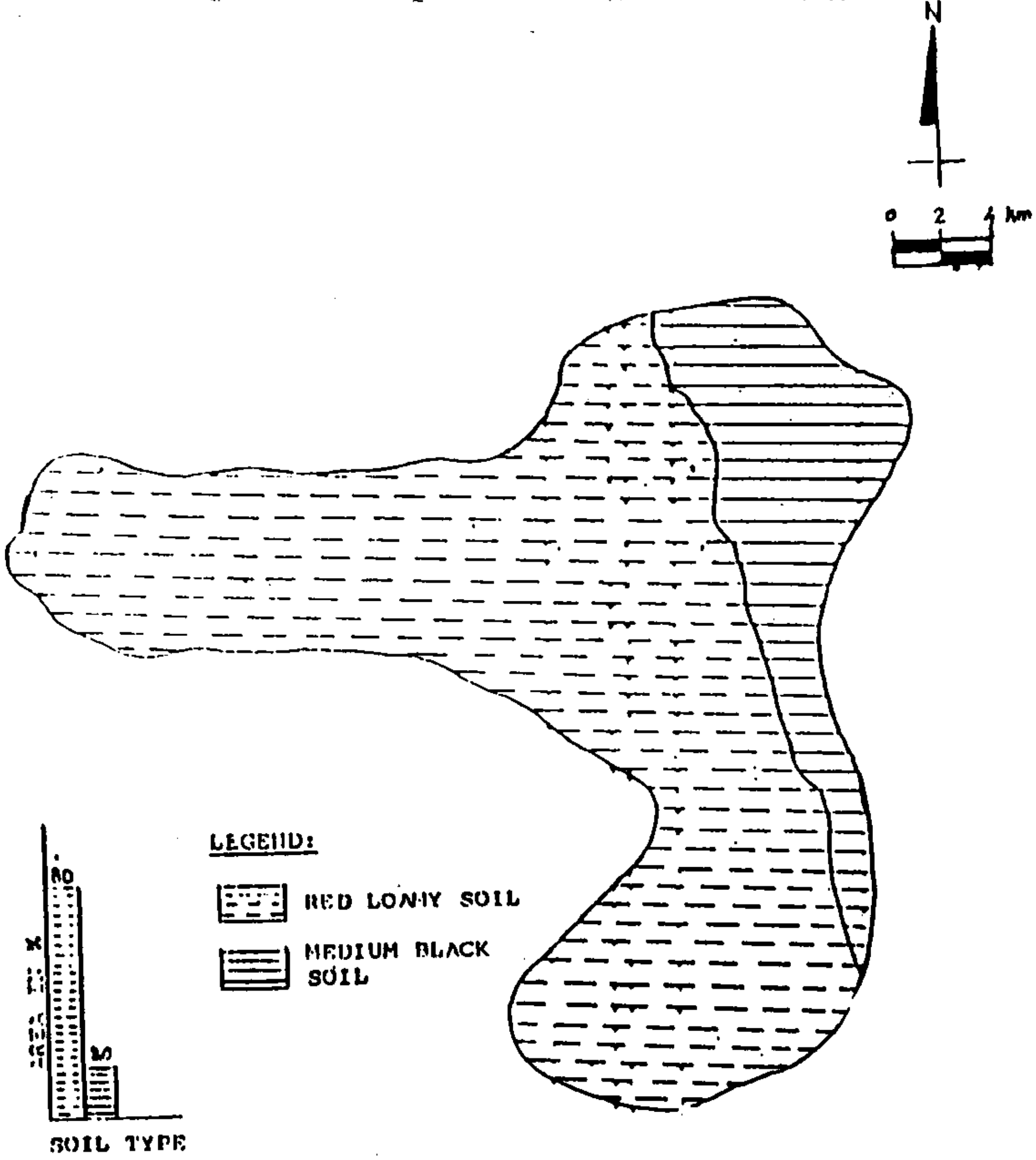



**Fig.3 Spatial distribution Map of different types of soils in the Malaprabha Representative Basin.**

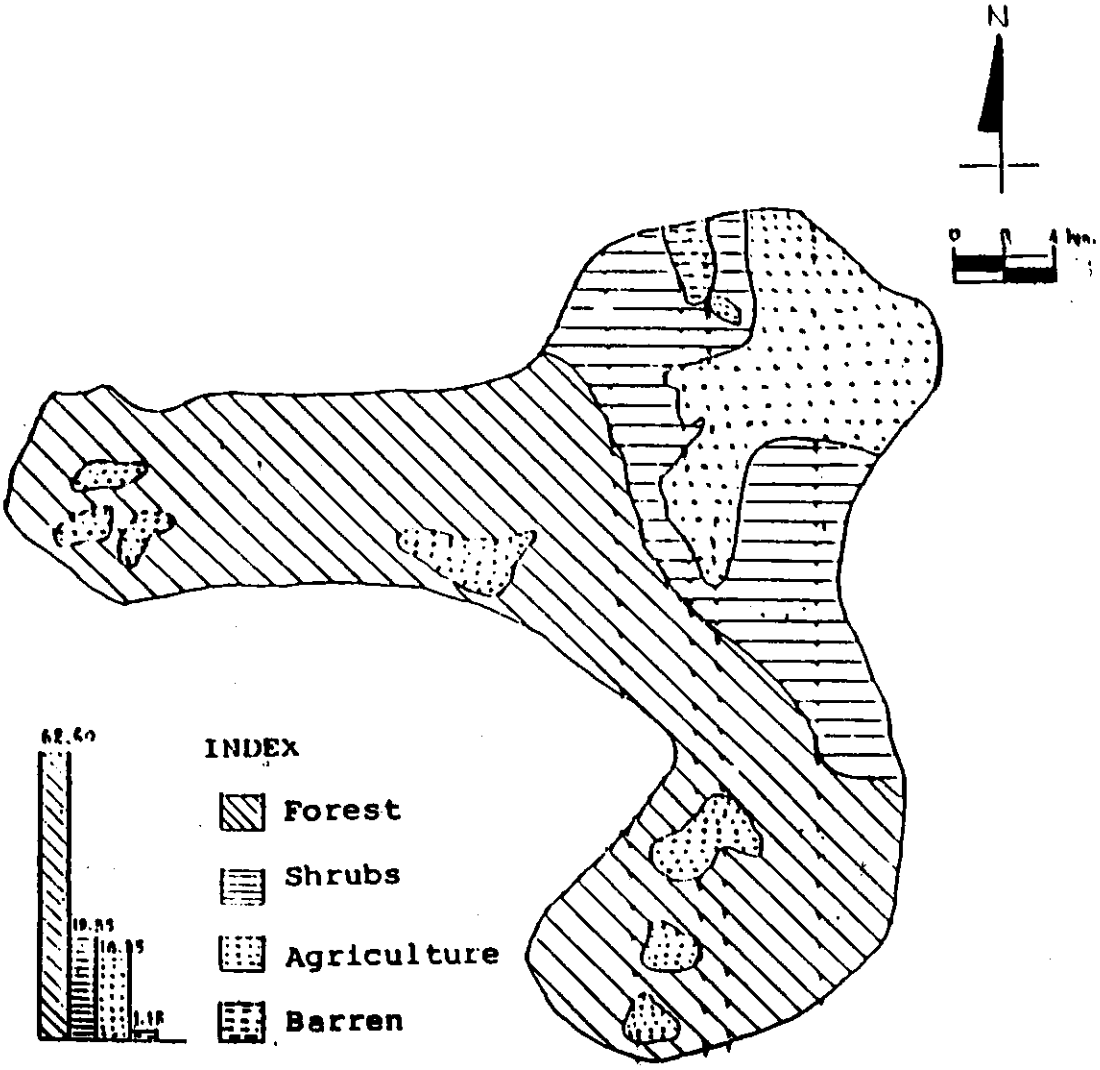



Fig.4 Spatial distribution Map of landuse pattern in the Malaprabha Representative Basin.

Figure 3 depicts the spatial distribution of these soils in the Malaprabha representative basin which reveals that the upper reaches of the basin i.e., on crest and gently sloping mid crest regions (viz. pediplain) are characterised by red loamy soil. The red loamy soils cover about 80% area of the total basin. The eastern part of the basin, mainly in parts of Khanapur taluk soils are characterised by medium black soils covering an area of 20% of the total area of basin ( Table 2).

2.1.4 Landuse Pattern : Figure 4 depicts the landuse pattern of the Malaprabha representative basin which reveals that it has a complex landuse pattern comprising of forest, agriculture, shrubs and barren land. Table 3 contains the distribution of area under these different landuses which reveals that a large part (62.6%) of the basin is covered by forest. About 19.35 % and 16.85% are is covered by shrubs and agriculture land respectivly.

## 2.2 The Ghataprabha Representative Bsain

2.2.1 Location :- The Ghataprabha representative basin lies in the western part of the Krishna basin between 15 46´ and 16 18´ N latitude, and 74 30´ and 74 49´ E longitude (fig 1). The basin encompasses an area of about 1055 sq km of Karnataka and Maharashtra states.

2.2.2 Geology :- The Ghataprabha representative basin is made up of two types of rock formations. These are (Fig 5);

1) Tertiary basalt and

2) Precambrian sedimentary

Figure 5 depicts the spatial distribution of these rocks in the Ghataprabha representative basin. Table 4 contains that 82% area of the basin is constituted of tertiary basalt and remaining 12% in the extreme south western part of the basin is made up of sedimentary rocks of Pre Cambrian age.

2.2.3 Soils :- The study area is divisible into three district groups of soils. These are (Fig 6);

1) lateritic coarse shallow soils

2) lateritic medium deep soils

3) coarse shallow black soils

The upper reaches of the Ghataprabha representative Basin is characterised by lateritic coarse shallow soils which covers about 29% area of the basin. The middle reaches are covered by lateritic medium deep soils covering an area of about 33% of he total basin. The lower reaches of the basin are characterised by coarse shallow black soils covering an area of about 38% of the total basin (Table 5).

Table 4: Distribution of area under different rock formations in the Ghataprabha representative basin

| | Rock formation | Area in sq.km | Area in % |
|---|---|---|---|
| 1. | Tertiary Basalts | 928.4 | 88.00 |
| 2. | Pre-cambrian sedimentaries | 126.6 | 12.00 |
| | Total | 1055 .00 | 100.00 |

Table 5: Distribution of area under different soil groups in the Ghataprabha representative basin

| | Soil groups | Area in sq.km | Area in % |
|---|---|---|---|
| 1. | Coarse shallow black soil | 400.90 | 38.0 |
| 2. | Medium deep soil | 348.15 | 33.0 |
| 3. | Coarse shallow soil | 305.95 | 29.0 |
| | Total | 1055 .00 | 100.00 |

Table 6: Distribution of area under different land use type in the Ghatprabha representative basin

| Sl.No | Land use type | Area in sq.km | Area in % |
|---|---|---|---|
| 1. | Forests | 145.6 | 13.8 |
| 2. | Shrubs | 369.7 | 35.05 |
| 3. | Fallow lands | 88.08 | 8.35 |
| 4. | Agriculture | 451.56 | 42.80 |
| | Total | 1055 | 100.0 |

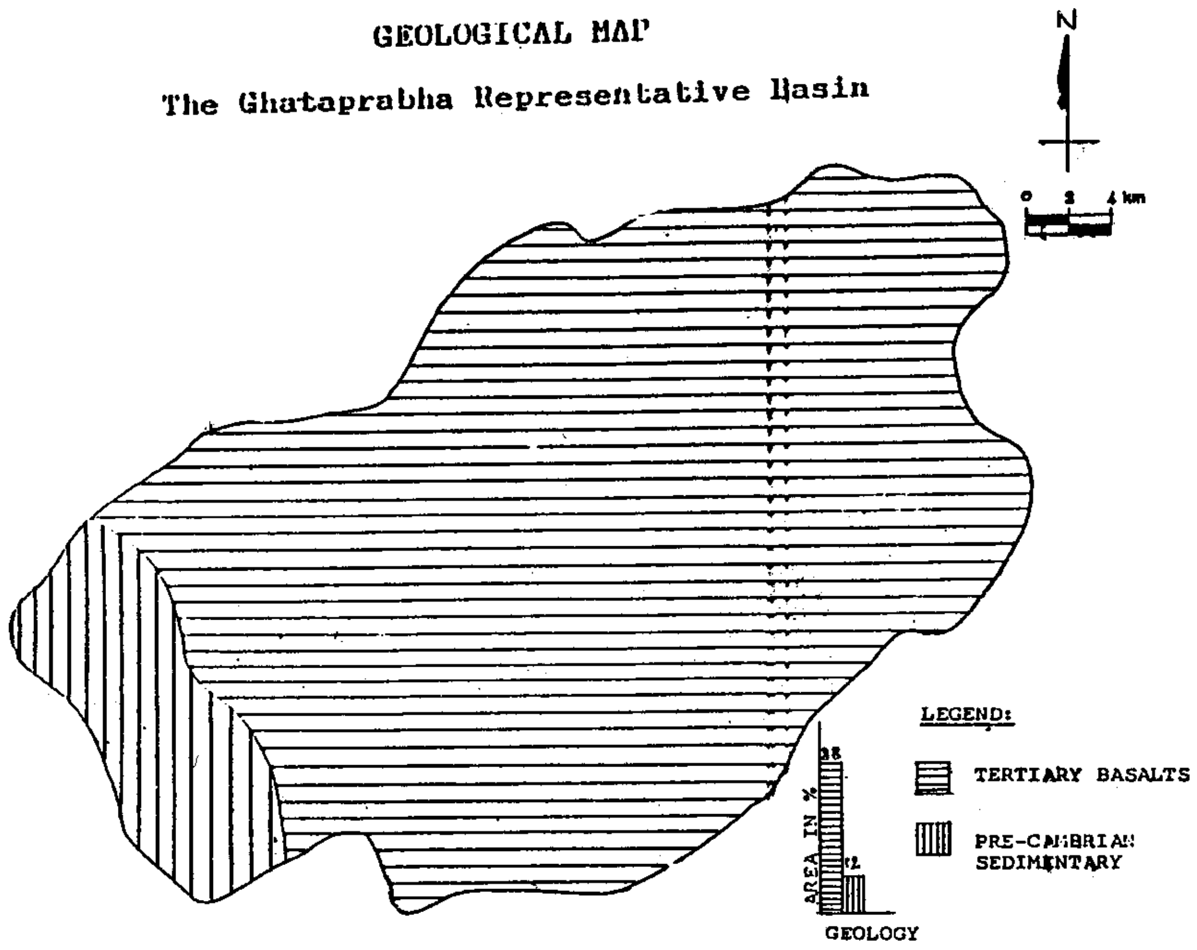



Fig No. 5 Geological Map of the Ghataprabha Representative Basin.

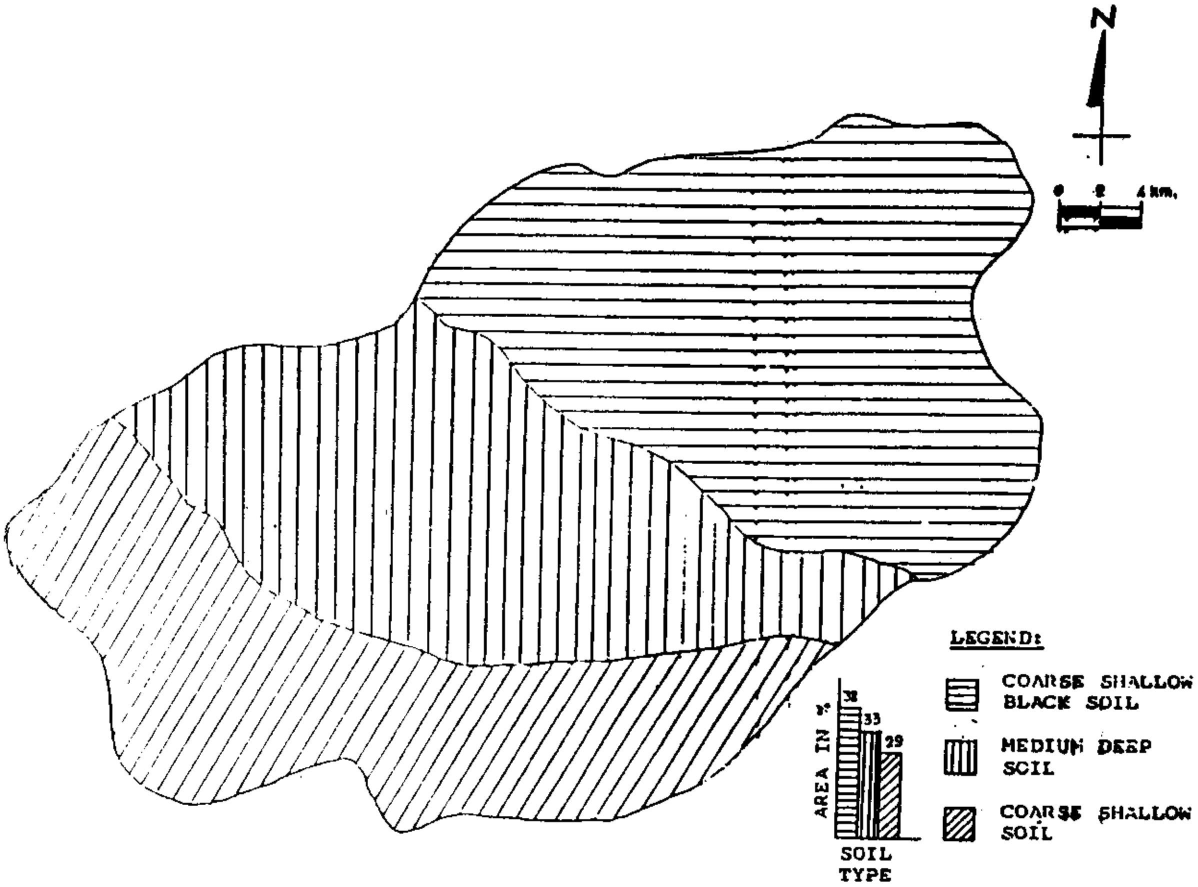



Fig No. 6 Soil Map of the Ghataprabha Representative Basin.

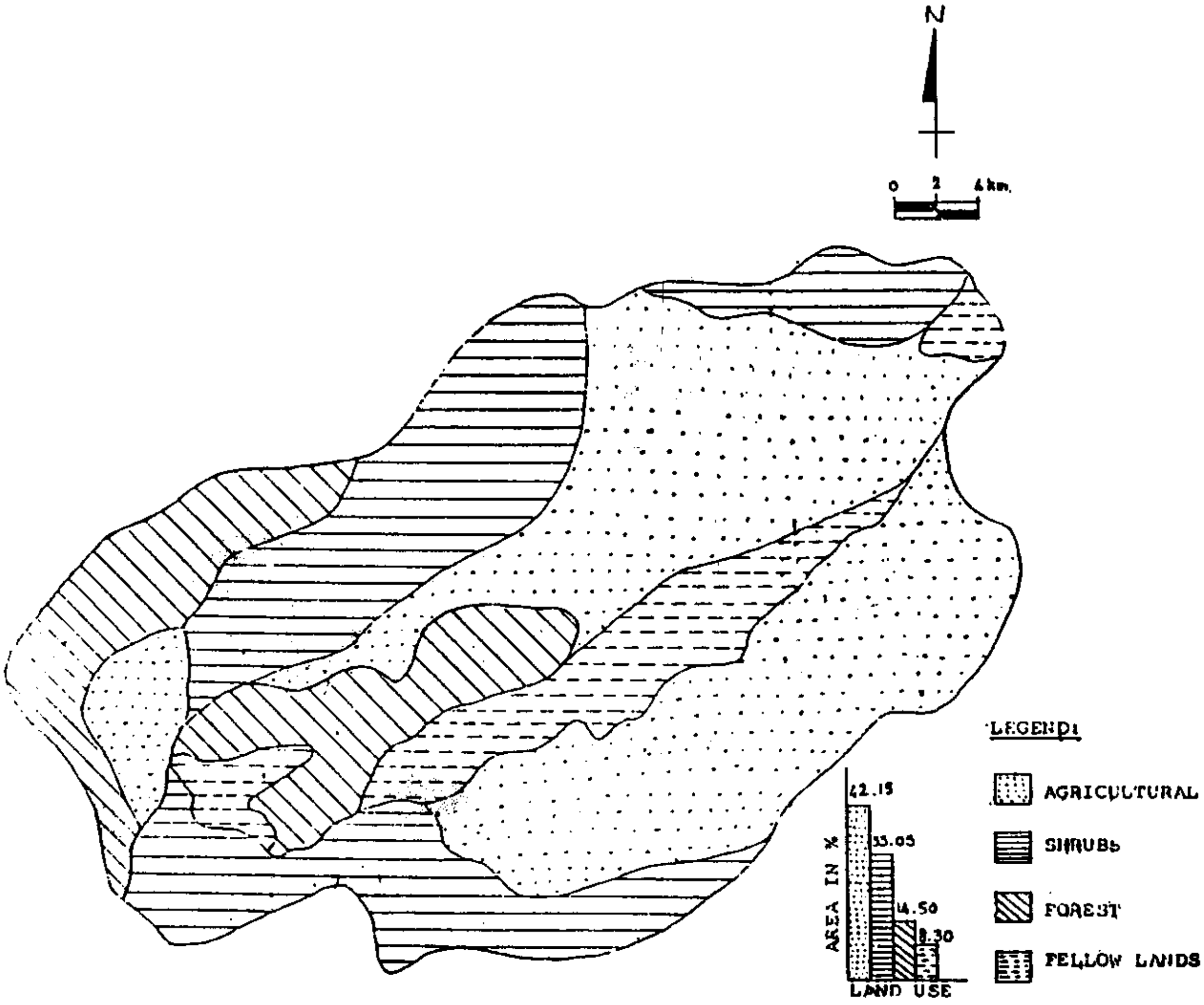



Fig. 7: LANDUSE PATTERN MAP OF THE GHATAPRABHA REPRESENTATIVE BASIN.

2.2.4 Landuse Pattern :- **Figure 7 depicts the pattern of** complex landuse pattern of the Ghataprabha representative basin. The distribution of area under different landuses is presented in the table 6 which reveals that a large part ie, 42.15% area of the total basin falls under agriculture land and forest cover includes only 14.5% area. About 35.05% area of the basin falls under shrubs on the eastern hillslopes and about 8,8% are falls under fallow land

# 3.Ø STRATEGY FOR INFILTRATION STUDY

## 3.1 Determination of Micro Hydrological Regions

As discussed in section two, the Malaprabha and Ghataprabha representative basins have complex Geological, peodological and landuse pattern. Therefore, stratified sampling technique was adopted to select samples for infiltration tests. An ideal sample represents to a certain environment. For the selection of an ideal sample , a thorough knowledge of the environment of the study area is required. Under a complex environment, ie. having different rock types, soil and landuse pattern etc., the Sampling based on only one geographical factor, say rock type or soil type, cannot be an ideal sample or unbiased sample. Hence, multi stage stratification of the study area by using different geographical maps is needed to minimize the variations in order to obtain the homogeneous regions.

## 3.2 Micro Hydrological Regions of the Malaphrabha Representative basin.

In order to determine the Micro hydrological regions of the Malaprabha representative basin an exercise was carried by using the available geological, soil and landuse maps (Fig 2,3 and 4). These maps indicates that the Malaprabha has a complex environment. A brief account of its environment is given below.

It is obvious from the complex geological, peodological and landuse pattern of the Malaprabha representative basin that a single geographical factor cannot be used as a base for determination of micro hydrological regions. For example, a single lithological region has different types of soils and landuse pattern. Thus if we consider the rock type as a base for sampling of infiltration ,then the sampie would not be an representative even for the same rock formation because;

* single rock formation of the Malaprabha representative basin is covered by two different types of soil which may effect significantly the infiltration with in the same rock formation; and

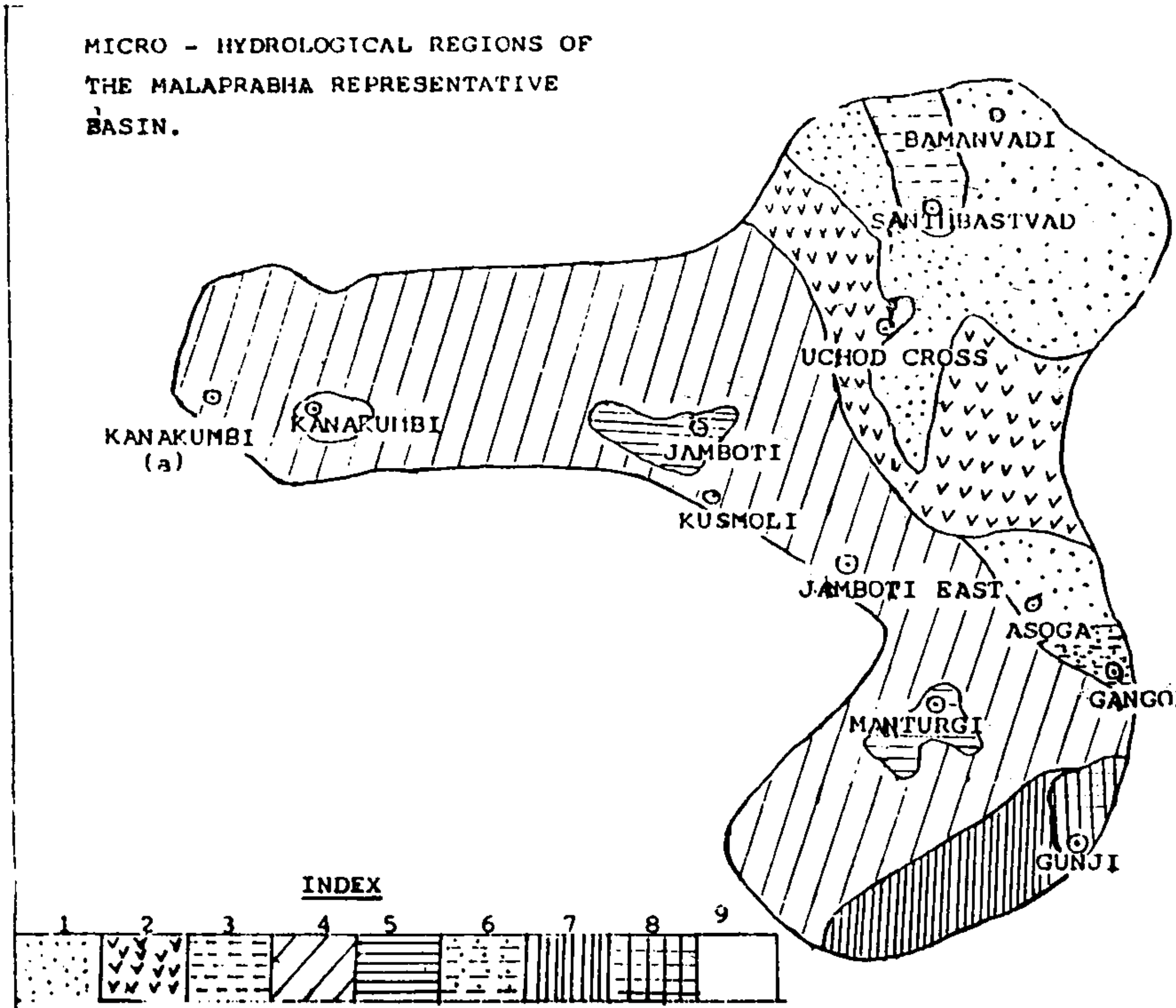
* A single soil region of Malaprabha representative basin is covered by different landuses i.e., forest, barren, agriculture, which may effect significantly the infiltration within the same soil region.

For sampling of infiltration study under such a complex environment, it is necessary to include all these complex geographical factors (ie., rock, soil, landuse) for determination of micro hydrological regions of the Malaprabha representative basin. Thus, in order to obtain the micro hydrological regions of the Malaprabha, the geological, soil and landuse maps were superimposed Based on the superimposition of these maps the Malaprabha representative basin is divisible into as many as nine micro hydrological regions (Table 7) as depicted in figure 8. These are;

1. agriculture land having medium black soil under lain by basalt
2. shrubs having medium black soil underlain by basalt
3. barren land having medium black soil underlain by basalt
4. forest land having red loamy soil underlain by basalt
5. agriculture land having red loamy soil underlain by basalt
6. forest land having medium black soil underlain basalt
7. forest land having red loamy soil underlain by sedimentary rocks
8. agriculture land having red loamy soil underlain by sedimentary rocks.
9. barren land having red loamy soil underlain by basalt

## 3.3 Micro Hydrological Regions of the Ghataprabha Representative Basin.

Ghataprabha representative basin has also complex geographical environment. Similar exercise was carried out in order




1. Agriculture land having medium black soil underlain by terriary basalts.
2. Shrubs having medium black soil underlain by tertiary basalt.
3. Barren land having medium black soil underlain by tertiary basalts.
4. Forest region having Red loamy soil underlain by tertiary basalt.
5. Agriculture land having red loamy soil underlain by tertiary basalt.
6. Forest land having medium black soil underlain by tertiary basalt.
7. Forest land having Red loamy soil underlain by pre - cambrian sedimentary rocks.
8. Agriculture land having Red loamy soil underlain by pre - cambrian sedimentary rocks.
9. Barren land having Red loamy soil underlain by Basalts.

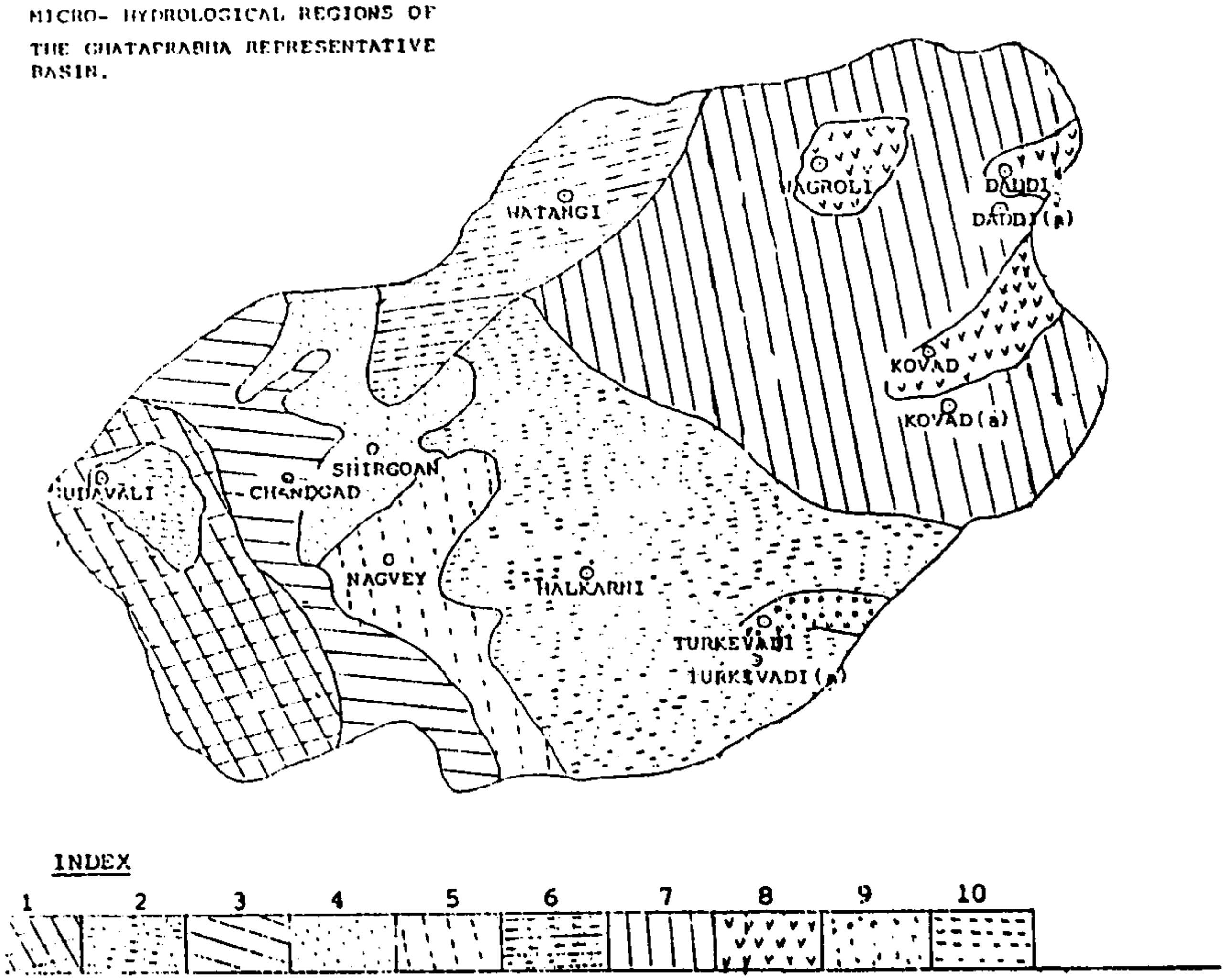
Fig.8: Micro - hydrological regions of the Malaprabha Representative Basi

Table 7 Distribution of area under different micro-hydrological regions of the Malaprabha representative basin.

| No. | Name of the region | Area sq km | % | No. of Samples |
|---|---|---|---|---|
| 1. | Agriculture land with medium black soil and basalt rocks | 100.0 | 18.52 | 2 |
| 2. | Shrubby area with medium black soil and basalt rocks | 53.25 | 9.86 | 1 |
| 3. | Barren land with medium black soil and basalt rocks | 7.81 | 1.44 | 1 |
| 4. | Forest area with red loamy soil and basalt rocks | 323.36 | 59.88 | 3 |
| 5. | Agriculture land with red loamy soil and basalt rocks | 15.62 | 2.89 | 2 |
| 6. | Forest area with medium black soil and basalt rocks | 6.25 | 1.16 | 1 |
| 7. | Forest arèa with red loamy soil and sedimentary rocks | 20.19 | 3.74 | * |
| 8. | Agriculture land with red loamy soil and sedimentary rocks | 7.81 | 1.44 | 1 |
| 9. | Barren land with red loamy soil and basalt rocks | 6.25 | 1.15 | 1 |
| | Total | 540.00 | 100.0 | 12 |

to obtain the micro hydrological regions of the Ghataprabha representative basin. This basin is divisible into ten different micro hydrological regions. These are;

1. forest land having coarse shallow soil and sedimentary rocks
2. agriculture land having coarse shallow soil and sedi mentary rocks.
3. shrubs with medium deep soil and basalt rocks.
4. agriculture land having medium deep soil and basalt rocks
5. forest land having medium deep soil and basalt rocks
6. shrubs with coarse shallow and basalt rocks
7. agriculture land having coarse shallow black soil and basalt rocks.
8. barren land having coarse shallow black soil and ba salts
9. barren land having medium deep soil and basalt rocks
10. agriculture land having medium deep soil and basalt rocks




1. Covered by forest with coarse shallow soil and sedimentary rocks.
2. Agriculture land with coarse shallow soil and sedimantary rocks.
3. Covered by shrubs with medium deep soil and basalt rocks.
4. Agriculture land with medium deep soil and basalt rccks.
5. Covered by forest with medium deep soil and basalt rocks.
6. Covered by shrubs with coarse shallow soil and basalt rocks.
7. Agriculture land with coarse shallow black soil and basalt rocks.
8. Barren land with coarse shallow black soil and basalt rocks.
9. Barren land with medium deep soil and basalt rocks.
10. Agriculture land with medium deep soil and basalt rocks.

Fig. 9: Micro - hydrological regions of the Ghataprabha representative basin.

Table 8: Distribution of area under different micro hydrological regions of the Ghataprabha representative basin.

| No. | Name of the region | Area sq km | % | No. of Samples |
|---|---|---|---|---|
| 1. | Forest land with coarse shallow soil and sedimentary rocks | 101.56 | 9.63 | * |
| 2. | Agriculture land with coarse shallow soil and sedimentary rocks | 17.19 | 1.63 | 1 |
| 3. | Shrubby area with medium deep soil and basalt rocks | 87.50 | 8.30 | 1 |
| 4. | Agriculture land with medium deep soil and basalt rocks | 56.25 | 5.33 | 1 |
| 5. | Forest area with medium deep soil and basalt rocks | 62.50 | 5.92 | 1 |
| 6. | Shrubby area with coarse shallow soil and basalt rocks | 62.50 | 5.92 | 1 |
| 7. | Agriculture land with coarse shallow soil and basalt rocks | 42.18 | 3.98 | 3 |
| 8. | Barren land with coarse shallow black soil and basalt rocks | 10.94 | 1.03 | 1 |
| 9. | Barren land with medium deep soil and basalt rocks | 275.00 | 26.10 | 2 |
| 10. | Agriculture land with medium deep soil and basalt rocks | 339.38 | 32.16 | 2 |
| | Total | 1055.00 | 100.0 | 13 |

## 4.0 SITE DESCRIPTIONS

The rate of infiltration of a given soil may be governed by different factors, ie, topographic conditions, soil characteristics, conditions of soil mass, soil-water state and landuse pattern etc. Therefore it is necessary to observe these environmental factors at and around the infiltration test site. For this purpose a field guide (appendix 1) was prepared to record site and situation, relief, rock type, vegetation, landuse pattern around theinfiltration test site and soil characteristics ie, texture, stoniness, structure, plant roots and soil moisture state etc. at the test site, cross section near the test sites were prepared, some of the examples of cross sections are presented in figures 10 to 13.

A brief description of each infiltration site of the Malaprabha and Gataprabha representative basin is given below.

### 4.1 Malaprabha Representative Basin

Site No.1 Asoga ( Fig.10) : The infiltration test site lies about 40 Km west of Belgaum at Asoga village in Khanapur taluk of Belgaum district. The infiltration test was carried out on a natural terrace having surface configuration of about to towards north-east direction. The terrace having an altitude of 670 m above MSL is made up of deep soil underlained by highly fractured (15 fractures/ meter) tertiary basalt. The terrace is used for cultivation of crops. During the test the terrace was covered with paddy crop and grasses having a ground cover of about 90%. Initially some 10/15 years back it was covered by forest.

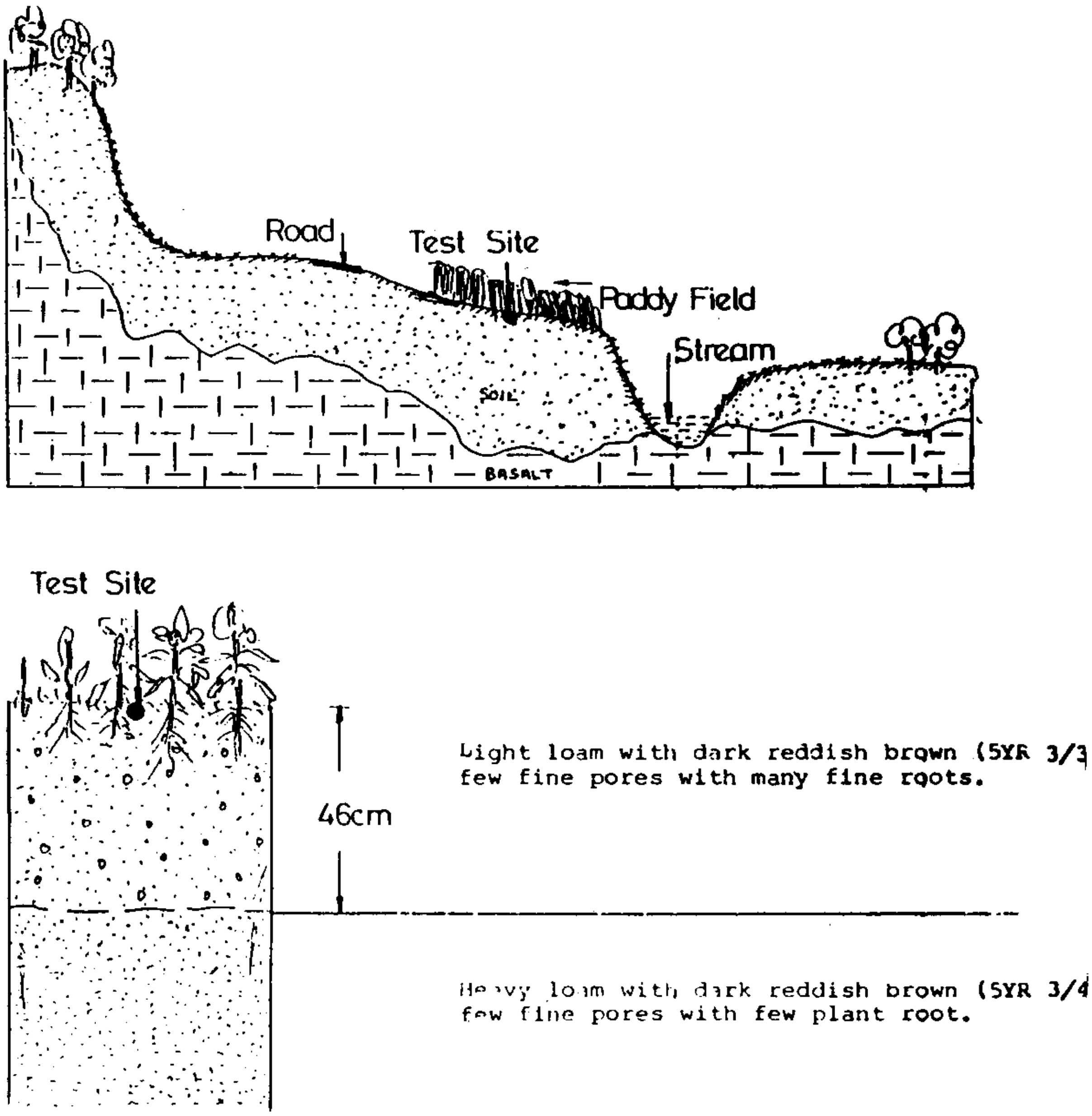
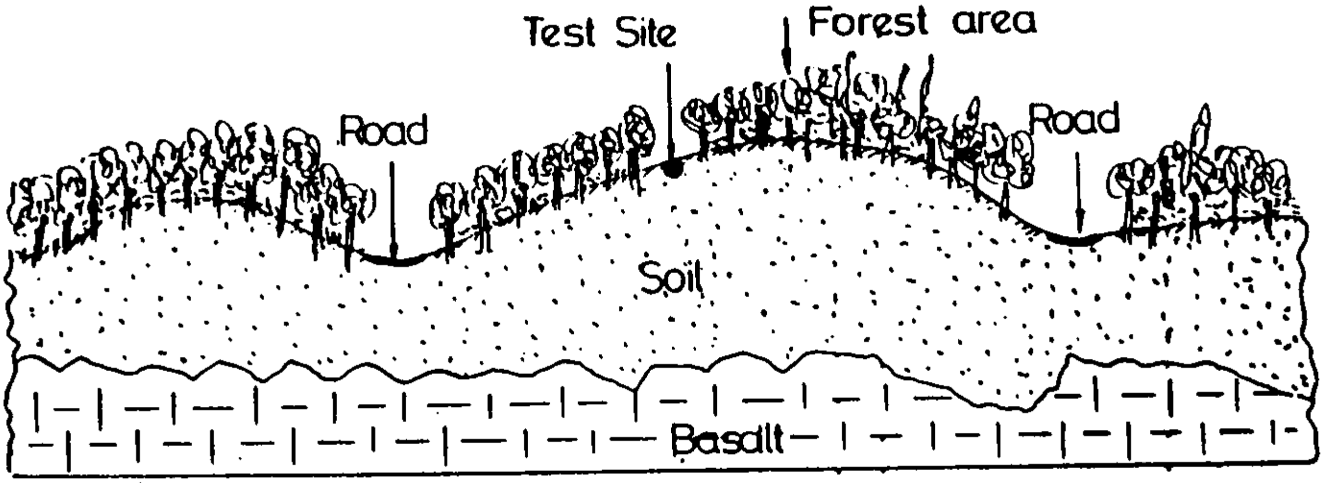
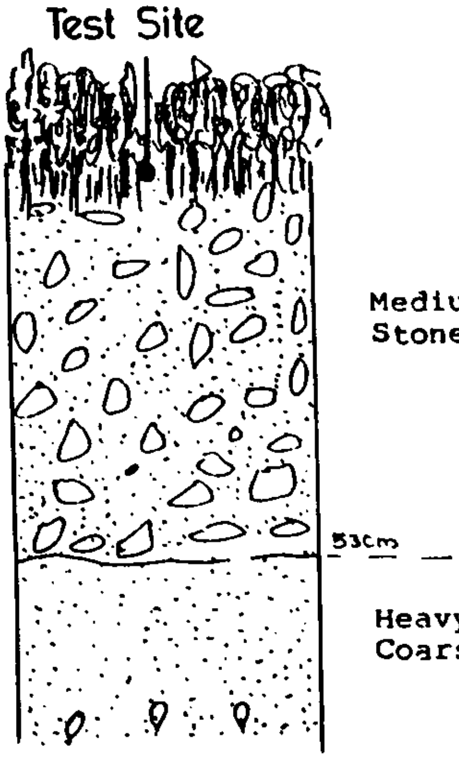



Fig. 10 Cross section showing the location and environment near site No. 1 at Asoga (above) and soil propile at test site (below).

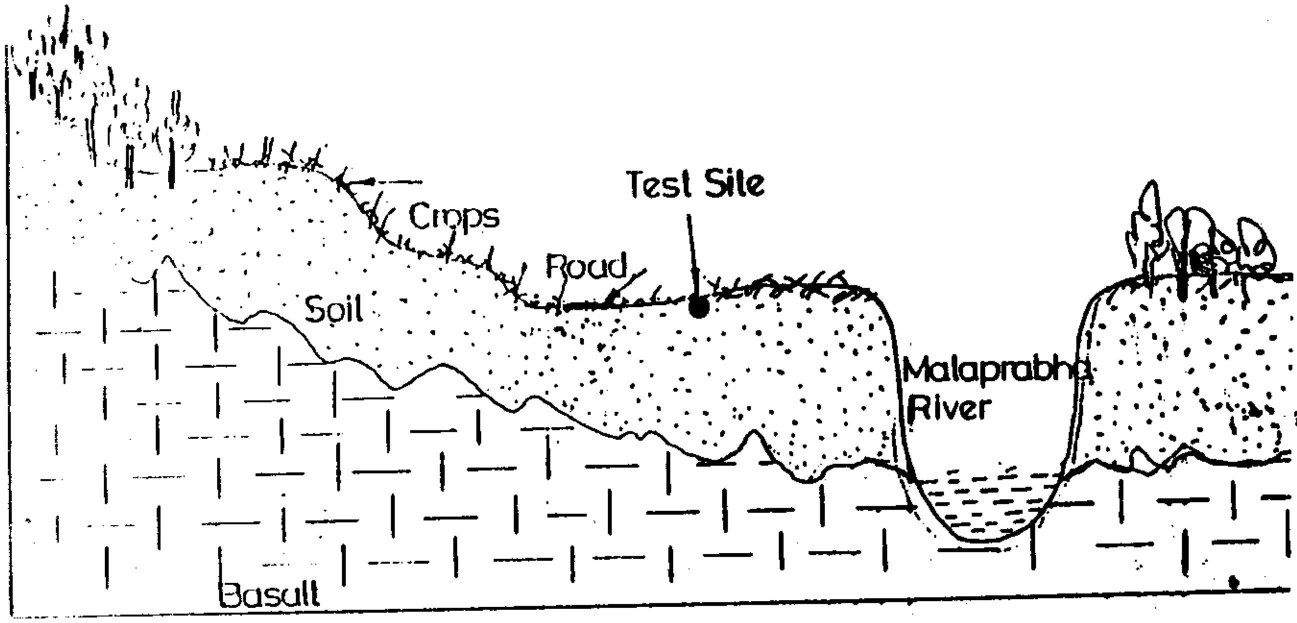


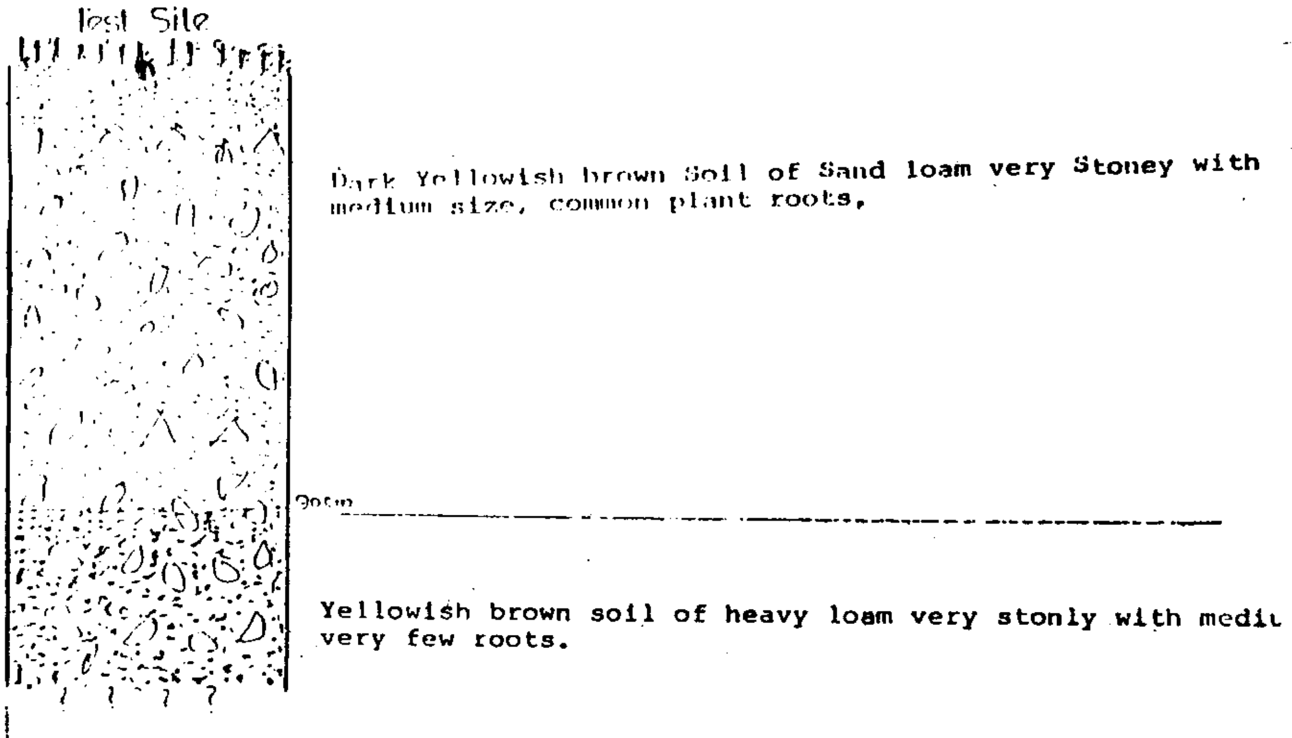




Medium Loam, Dark Reddish Brown (5YR 3/4) Very Stoney with medium type Stones.

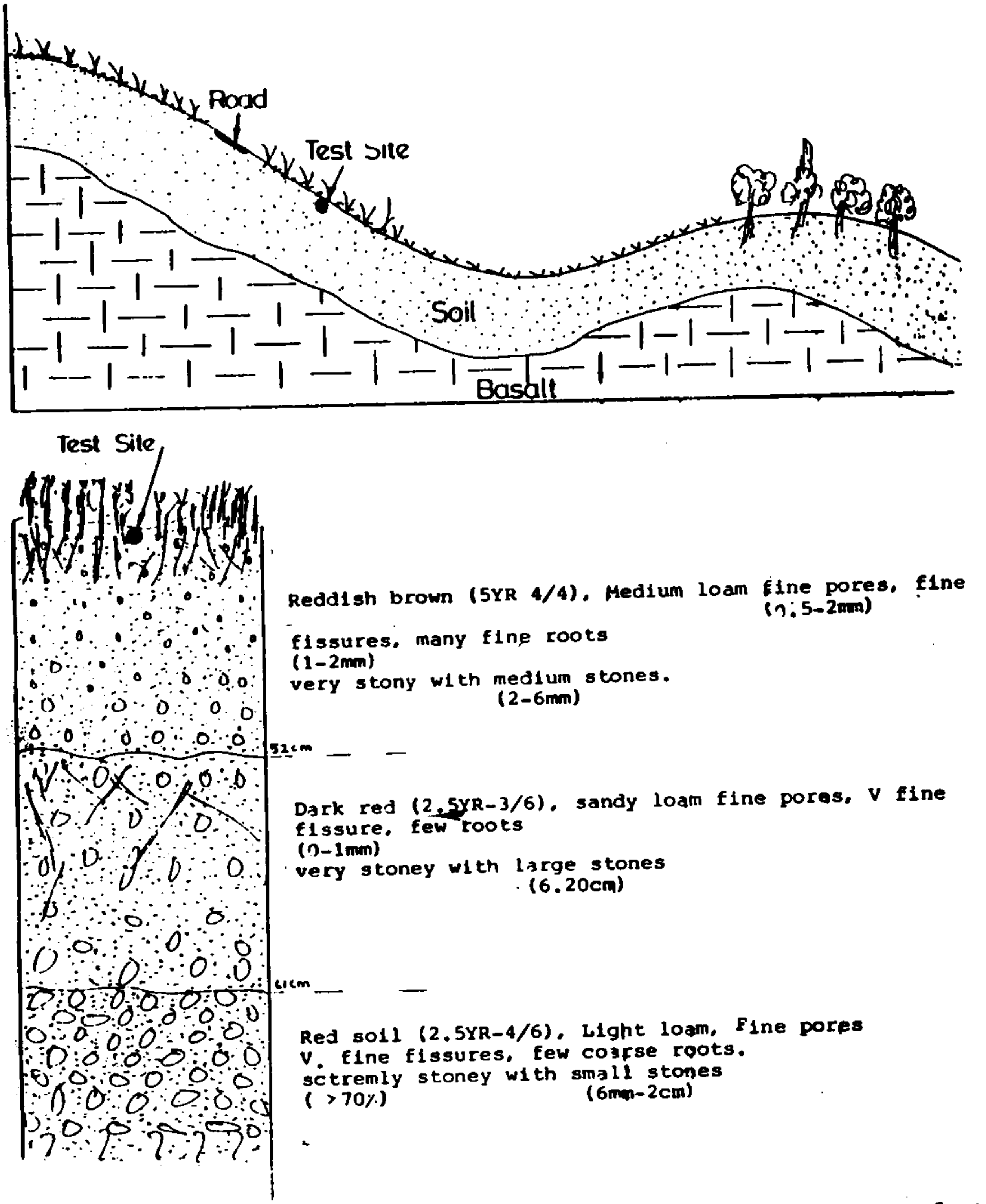
Heavy Loam, Reddish Brown (5YR 4/4) Stoneless, Coarse roots.

Fig. 11: Cross section showing the location and environment near site No. 2, 8Km east of Jamboti (above) and Soil profile at test site (below).




1.12: Cross section showing the location and environment near site No. 3, Kunkumbi (above) and soil profile at test site (below)




ig. 13: cross section showing the location and environment near site No. 5 at Tamboti (above) and soil profile at test site (below).

As shown in the figure 10 the soil is divisible into two horizons. The top layer soil upto a depth of about 46cm is made of dark reddish brown (5YR 3/3), moderately stony, light loam. It is characterised by few fine pores, fine fissures and many plant roots of medium size.

The sub soil horizon is made up of dark reddish brown (5YR 3/4), stoneless heavy loam, characterised by few fine pores, very fine fissures and very few plant roots.

Site No.2 8 km. East of Jamboti (Fig.11) : The infiltration test site no.2 is lies about 8 Km east of Jamboti at an altitude of about 712 m above MSL in Khanapur taluk in Belgaum dist. The test site lies on the crest of a hill having convex slope of about 6o towards East. The crest of the hill is capped with a weathered materials underlained by tertiary basalt. The area is covered by thick forest dominated by teakwood and bamboo. The forest is is having a tree density of about 40 to 50 trees per 100 sq.m with some 80% tree canopy. The ground is covered by grass with ground cover of about 40%.

The texture of the soil upto a depth of about 52cm. is of medium loam with dark reddish brown colour (5YR 3/4). The soil is very stoney with medium size stones and characterised by fine pores, fine fissures and fine plant roots.

The sub soil layer is having the colour reddish brown (5YR 4/4) and its texture is heavy loam. The soil is stoneless and is characterised of fine pores, fine fissures with some coarse roots.

Site No.3 Kankumbi (Fig.12) : The infiltration test site lies about 60Km. from Belgaum in Kanakumbi. It is at an altitude of about 792 m above MSL in Khanapur taluk of Belgaum district. The test was conducted on a natural barren terrace with a surface configuration of about 1o towards East. The terrace is made up of deep soil about 10m depth which is underlained by tertiary basalt with lateretic out crop. During the test the site was covered with grass.

The soil has two horizons. The top layer upto a depth of about 90 cm is made up of sandy loam dark yellowish brown (10YR 4/4) in colour. The soil is very stony and is characterised by fine pores, very fine fissures and fine plant roots.

The sub soil layer soil is made up of heavy loam Yellowish brown (10YR 5/6). It is very stony and characterised with fine pores, fissures and few plant roots.

Site No.4 Kankumbi : The fourth infiltration test was conducted in Kankumbi forest area at an altitude of 792 m above MSL. The site lies on the convex crest of the hill with surface configuration of about 1o towards North. The crest is made up of deep soil underlained by basaltic rock. Site was covered by grass with a ground cover of about 70% when the test was conducting.

The soil upto 1 m is made up of dark reddish brown(5YR3/3) sandy loam and is very stony of medium size stones. It is characterised with medium pores, fine fissures and medium plant roots.

Site No.5 Jamboti (Fig.13): The fifth infiltration test was conducted in Jamboti about 45 km from Belgaum at an altitude of 868m above MSL. The surface has a slope of about 5o towards North West direction. The area is under agricultural land and was covered by forest before 10-20 years. The area has of deep soil and underlained by tertiary basalt. The ground cover was about 80% covered by ragi crop and grass during the monsoon period.

The soil is divisible in to three distinct layers. The top layer of soil upto a depth of about 52 cm is made up of reddish brown (5YR 4/4). medium loam soil. It is very stoney and is characterised with fine pores, fine fissures and many fine plant roots.

The second layer upto 61cm is made up of sandy loam, dark red(2.5YR-3/6). It is very stony soil and is characterised with fine pores and fissures and few plant roots.

The third layer is of extremely stony light loam with red colour(2.5YR-4/6). It is characterised with fine pores and very fine fissures.

Site No.6 Bamanavadi : The sixth infiltration site at Bamanavadi lies about 20 km from Belgaum at an altitude of about 745m above MSL in Belgaum taluk. The site lies on a flat natural terrace with a ground slope of about 1o towards North-East. The deep soil is underlained with basaltic rock. The land is used for agriculture and at the time of test it was covered with grass having a ground cover of about 50%.

The soil upto a depth of about 1.5m is of dark brown(10YR-3/3) in colour and has heavy loam texture. It is moderatly stony soil and is characterised with fine pores, fine fissures and many fine roots.

Site No. 7 Santibastvad : This infiltration site at Santbastvad lies about 25 km from Belgaum at an altitude of about 762m above MSL in Belgaum district. The site is a natural barren terrace with a ground slope of about 2 towards North-East.The land having grass covering of about 90%.

The texture of the soil is clayey and it is dark brown(10YR-3/3) in colour. It is stoneless and is characterised with fine pores,fine fissures and many fine roots.

Site No. 8 Uchode cross : The eighth infiltration site lies about 35 km from Belgaum at an altitude of about 740m above MSL in Khanapur taluk of Belgaum district. The site lies on the spur of a hill having a convex slope of about 30o towards South-West. The area has deep soil underlained by basaltic rock and covered with forest and shrubs having a density of about 20 to 25 trees /100 Sq.m. The tree canopy stands at 20% and about 90% of ground is covered with grass.

The soil up to a depth of about 1.5m is made of dark brown(10YR-3/3) clayey soil. It is very stony of large size stones and is characterised by fine pores,medium fissures,contains many medium plant roots.

Site No.9 Kusmoli : The ninth site in Kusmoli lies about 45 km form Belgaum at an altitude of about 712m above MSL in Khanapur taluk. The site lies on a spur of hill which has concave slope of about 5o towards South-West. The area is shrubby having a density of about 25 to 30 shrubs per 100 Sq.m and 90% ground is covered with grass.

The area is of deep soil underlained by basaltic rock. The top layer upto a depth of about 65 cm i made up of yellowish red(5YR-4/6) heavy loam, very stony with medium size stones and is characterised by medium pores, fine fissures and medium plant roots.

The sub soil is dark red (2.5YR-3/6) heavy loam. It is extremely stony with medium stones and is characterised by fine fissures,fine pores and coarse plant roots.

Site No.10 Gangoli : This infiltration site near Gangoli lies about 25 km from Belgaum at an altitude of about 680 m above MSL in khanapur taluk. The site is on a natural flat terrace with surface slope of about 1o towards North-East. The area is covered with forest of different type of trees and shrubs. The tree density is 25 to 30 trees per 100 Sq.m with tree canopy of about 50% and density of shrubs is about 20 to 25 shrubs per 100 Sq.m.

The soil upto the depth of about 60cm. is made of brown(10YR-5/3)colour light loam soil. It is moderetely stony soil and is characterised by fine pores,very fine fissures and medium size plant roots

Site No.11 Gunji : The infiltration site at Gunji lies about 45 km from Belgaum at an altitude of about 686 m above MSL in Gunji taluk in Belgaum district. The site is selected on valley of concave slope with a ground slope of about 10o towards South-west direction. The site is near the river Haltar. At the time of the test the land was under cultivation of paddy crop. The 70% of the ground was covered with grass. Before some 20 years back the area was covered with forest. The land is of deep soil underlained by schist.

Top soil upto a depth of about 47cm is made up of dark brown(10YR-3/3) heavy loam soil. It is slightly stony of small size and is characterised by medium pores,fine fissures.

The sub soil is dark brown (7.5YR-4/4) clayey and is characterised with medium pores and fine fissures.

Site No.12 Manturgi : This site near Manturgi lies about 30km from Belgaum at an altitude of about 700 m above MSL in Khanapur taluk. The site is on a flat area which is having a slope of 1 towards South-West The valley is of agricultural land. The area is of deep soil underlained with basaltic rock. During the test the land was covered with paddy crop and grass with a ground cover of about 80%.

The soil up to a depth of about 70cm is made up of yellowish brown (10YR-5/4) medium loam soil. It is moderately stony and is characterised by fine pores, very fine fissures and many fine plant roots.

## 4.2 The Ghataprabha Representative Basin.

The environmental characteristics were observed near all the 13 infiltration test sites of the Ghataprabha Catchments during infiltration tests. A brief description of each site is given below.

Site No.1 Daddi : This site is at a distance about 80 km from Belgaum and lies at an altitude of about 681 m above MSL in Sankeswar taluk in Belgaum district. The area has deep soil underlained by basaltic rock. The test site covered by paddy crop during the monsoon test and the ground cover was found about 90%.

The top soil upto a depth of about 50cm is made of yellowish brown (10YR-5/8) heavy loam. It is stoneless and is characterised by medium pores, fine fissures and many fine roots.

Site No.2 This site lies on abandent land at Daddi having the elevation of about 694 m above MSL. The site is on a spur having surface configuration of about 5 towards North-East. The area has deep soil underlained by basaltic rock. The 75% of ground was covered by grasses during monsoon test.

The top soil upto 62cm depth is made of reddish brown(5YR-4/3) medium loam soil. It is very stony soil of medium size stones and is characterised by fine pores and fine fissures.

Site No.3 Waghroli: The third infiltration site at Wagroli lies at a distance of about 50Km from Belgaum at an elevation of about 712 m above MSL in Gadhinglaj taluk in Kolhapur district. The test site is on a barren crust of hill composed of basaltic rocks having convex slope with the surface configuration of 2 towards North-East. The 90% of the ground was covered by grasses during the monsoon test.

The top soil up to 50cm is of reddish brown (5YR-4/4) heavy loam. It is very stony soil with medium size of stones and is characterised by medium size pores, very fine fissures and many fine plant roots.

Site No.4 Watangi: The fourth infiltration site at Watangi lies about 55Km from Belgaum at an altitude of about 900m above MSL in Gadinglaj taluk in Kolhapur district. The site is on the spur of hill composed of basaltic rock is covered with shrubs. The density of shrubs is about 10 to 15 per 100sqm having a shrubs canopy of about 20%. The surface near test site is concave with a configuration of 5 towards North-West and have deep soil. The ground cover of shrubs and grasses stands at 70%.

The top soil up to a depth of 80cm is made up of dark reddish brown (5YR-3/4) medium loam. It is stoneless, and is characterised by fine pores, fine fissures and many medium size plant roots. The subsoil is of dark reddish brown (5YR-3/3) light loam. It is very stony soil and is characterised by fine pores, very fine fissures and few coarse plant roots.

Site No.5 Chandgad : The fifth infiltration site at an elevation of 700m above MSL in Chandgad lies about 55Km form Belgaum in Chandgad taluk of Kolhapur district. This is disturbed shrubby land with a density of about 10 to 12 per 100sqm. The land was covered with grasses having a ground cover of about 90% during monsoon.

The top soil upto 1 m is made up of dark reddish brown

(5YR 3/3) light loam. It is very stony soil of medium size stones and is characterised by medium pores, fine fissures and many fine plant roots.

Site No. 6 Gudavali: The sixth infiltration site at an altitude of 787m above MSL in Gudavali is about 65Km from Belgaum. Kolhapur district. The site lies on a valley floor having surface configuration of about 1 towards South-West. Before some 15 or 20 years back the land was covered by forest, presently is being used for cultivation of crops. The land was covered with ragi crop and grasses with a ground cover of about 90% during monsoon.

The top soil upto 1 m depth is made up of brown(7.5YR-4/4)light loam. It is very stony and is characterised by fine pores, fine fissures and many medium sine plant roots.

Site No.7 Nagvey : The seventh infiltration site at an altitude of 911 m above MSL in Nagvey lies about 50Km from Belgaum in Chandgad taluk of Kolhapur district. The site is located on the crest of the hill having convex slope with surface configuration of about 1 towards South-West. The area is covered by dense forest of different kind of trees. The tree density is about 30 to 40 per 100sq.m and the tree canopy is stands at 80% and the ground cover stands at 50%.

The top soil laver upto 1 m depth is made up of dark reddish brown (5YR-3/4)heavy loam soil It is stoneless soil and is characterised by fine pores, medium fissures and many medium type plant roots.

Site No.8 Thurkevadi: The eighth infiltration sites is in Thurkevadi which is about 40Km from Belgau is at an altitude of 700 m above MSL in Chandgad taluk in Kolhapur district. The site is located on a natural terrace with flat surface having the ground configuration of >1 towards West. The site is on crop field of ragi The area is of deep soil underlained by basaltic rock and has a ground cover of about 80%.

The top layer of soil up to a depth of 80cm is made of dark reddish brown(5YR-3/3), moderately stony,medium loam soil. IT is characterised by fine pores,fine fissures and fine plant roots in common.

Site No.9 Thurkevadi : The ninth infiltation sites is in Thurkevadi which is about 40Km from Belgaum is at an altiude of 700m above MSL in Chandgad taluke of Kolhapur district. The site is located on a natural terrace with flat surface having the ground configuration of >1 towards West. The site is on barren land and has deep soil underlained by basaltic rock. The site has a ground cover of about 50%.

The top layer of soil upto 60cm is made up of dark red (2.5YR-3/6),moderately stony,medium loam soil and is characterised by fine pores,fine fissures and few plant roots.

Site No.10 Halkarni : The tenth site at Halkarni lies at an altitude of 700m above MSL is about 45 km. from Belgaum in Chandgad taluk of Kolhapur District. The site is located on a crest which has convex slope with surface configuration more than 5o towards North-West. The area has deep soil used for the cultivation of sugarcane and is underlained by basaltic rock. 90% of the ground was covered with grasses during monsoon. Top soil layer upto 60cm is made of reddish brown (5YR-4/4) medium loam soil. It is moderately stoney soil and is characterised by medium pores fine fissures and fine plant roots in common.

Site No.11 Shirgaon : The eleventh infiltration site at Shirgaon is at a distance of 55 km from Belgaum in Chandgad Taluk. It lies at an altitude of 708 m above MSL on a natural flat terrace with less than 1 slope. The land is used for cultivation of crops. During the monsoon period it was covered by sugarcane crop and grass with a ground cover of about 90%.

The top soil layer upto 50 cm is made of dark reddish brown (5YR 3/4) heavy loam soil. It is stoneless soil and is characterised with fine pores, fine fissures with many fine plant roots.

Site No.12 Kovad : The twelth infiltration site at Kovad lies about 35 km from Belgaum in Chandgad taluk. The site is located at an elevation of 691m above MSL on the barren crest of hill having convex slope with surface configuration of 45o towards South-West. The area has shallow soil underlained by basaltic rocks. The 80% of the ground was covered with grasses during mosoon test.

The soil is made of dark brown (10YR-3/3) medium loam. It is extremely stoney and is characterised by fine pores, fine fissure and fine roots.

Site No.13 Kovad : This site is located on spur of the same hill as described in site no.12. The land is abadant. Soil is made up of dark brown (10YR- 3/3) medium loam. It is extremely stoney and is characterised by fine pores, fine fissures and fine roots.

## 5.Ø INFILTRATION CURVES OF MALAPRABHA AND GHATAPRABHA REPRESENTATIVE BASINS DURING MONSOON AHND POST_MONSOON SEASONS (1992-1993)

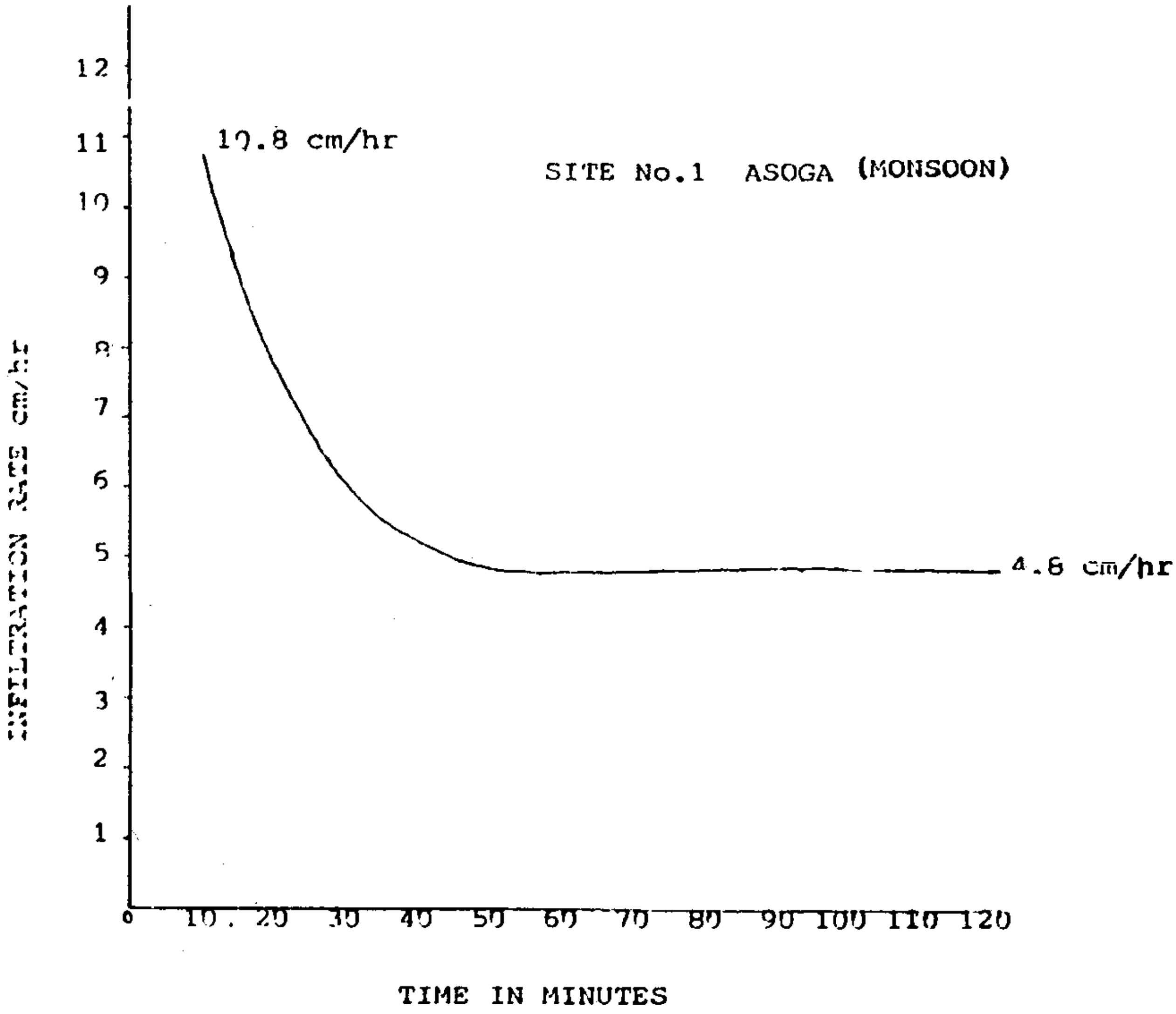
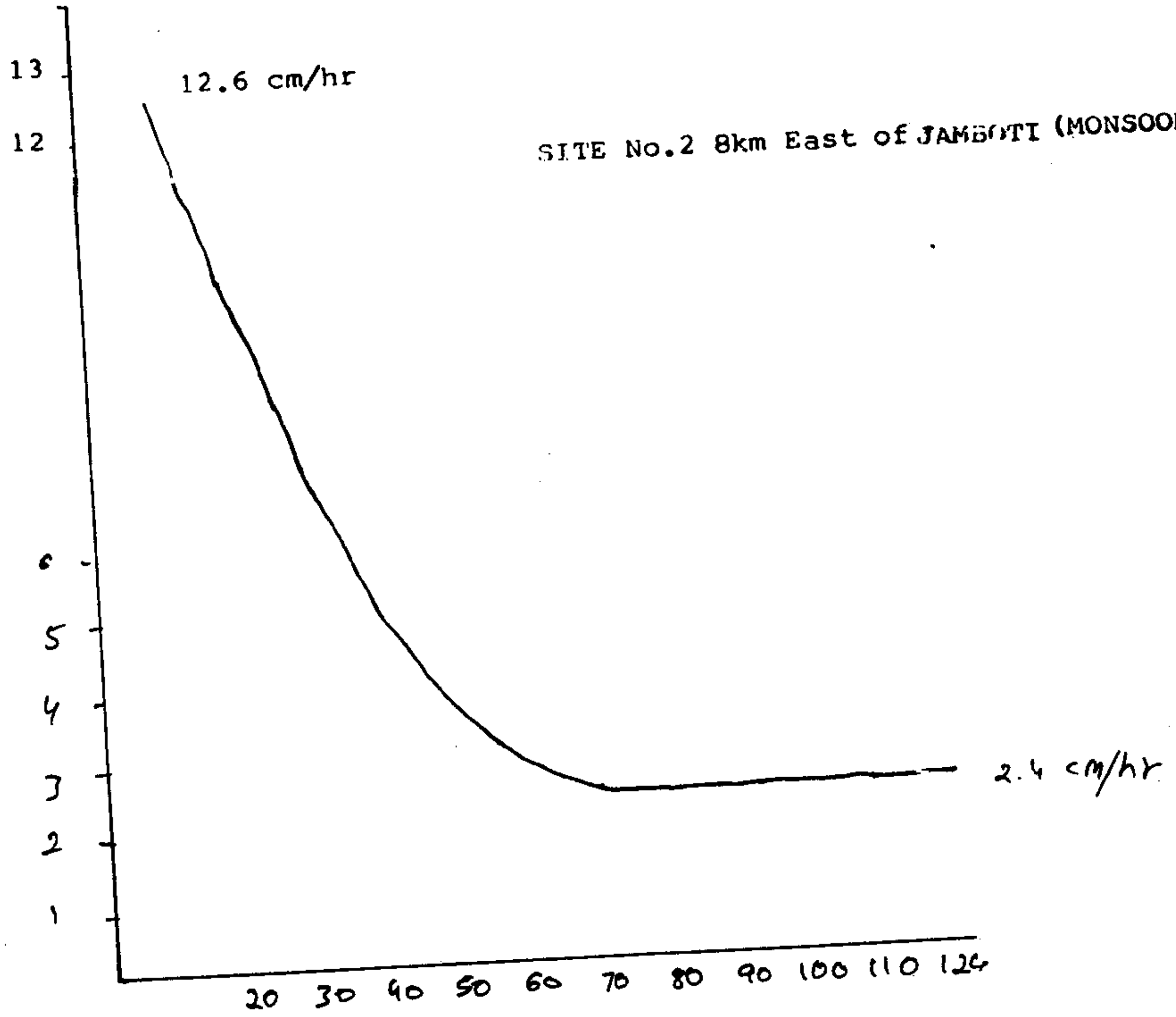



Fig:14. Infiltration curve at Asoga site on agricultural land covered by heavy loam soil and underlain by basalt.


13
12
12.6 cm/hr
SITE No.2 8km East of JAMBOTI (MONSOON)
6
5
4
3
2
1
2.4 cm/hr
20 30 40 50 60 70 80 90 100 110 124

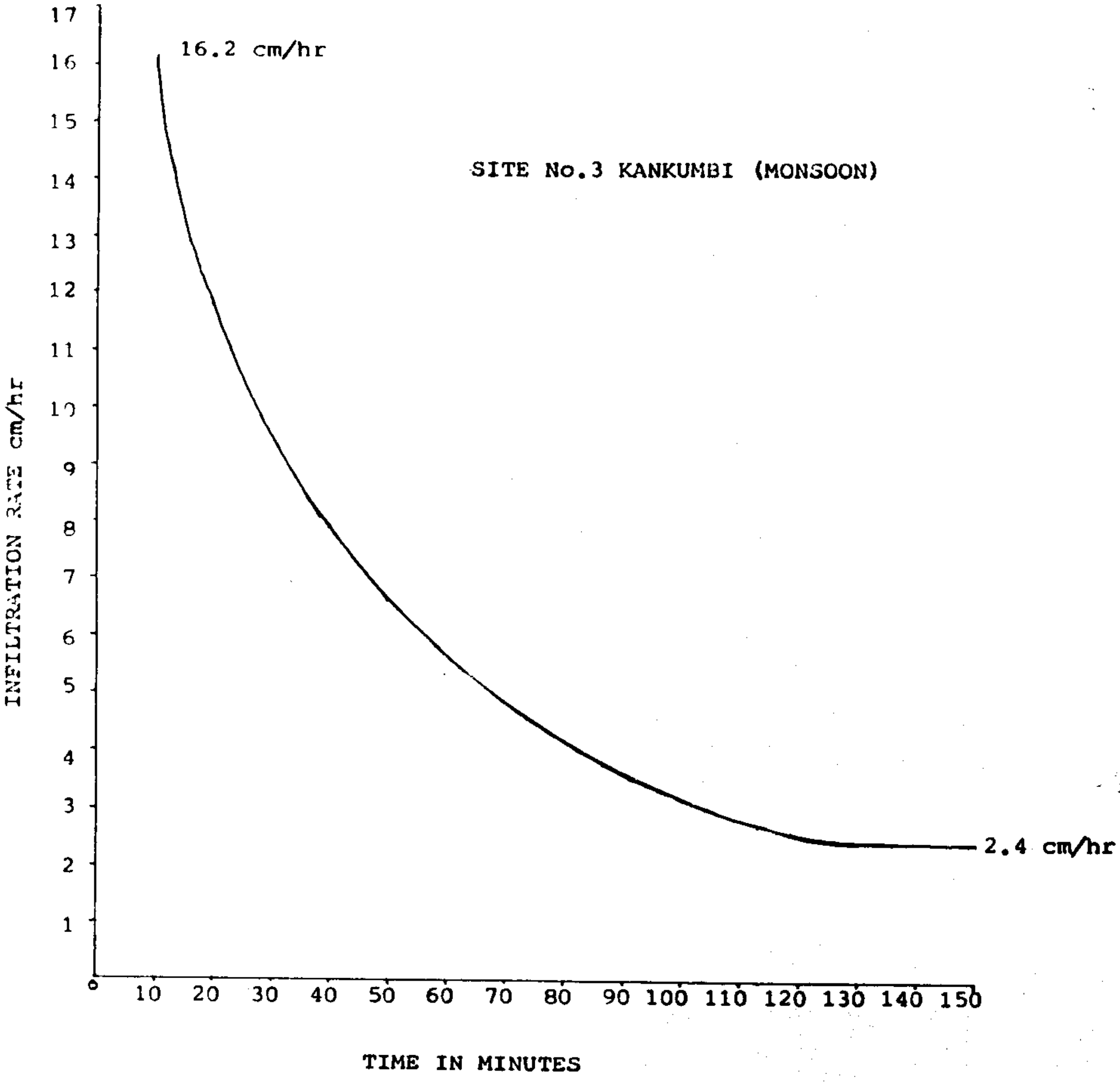



Fig. 16. Infiltration curve at Kankumbi site on barren land covered by sandy loam soil and underlain by basalt.

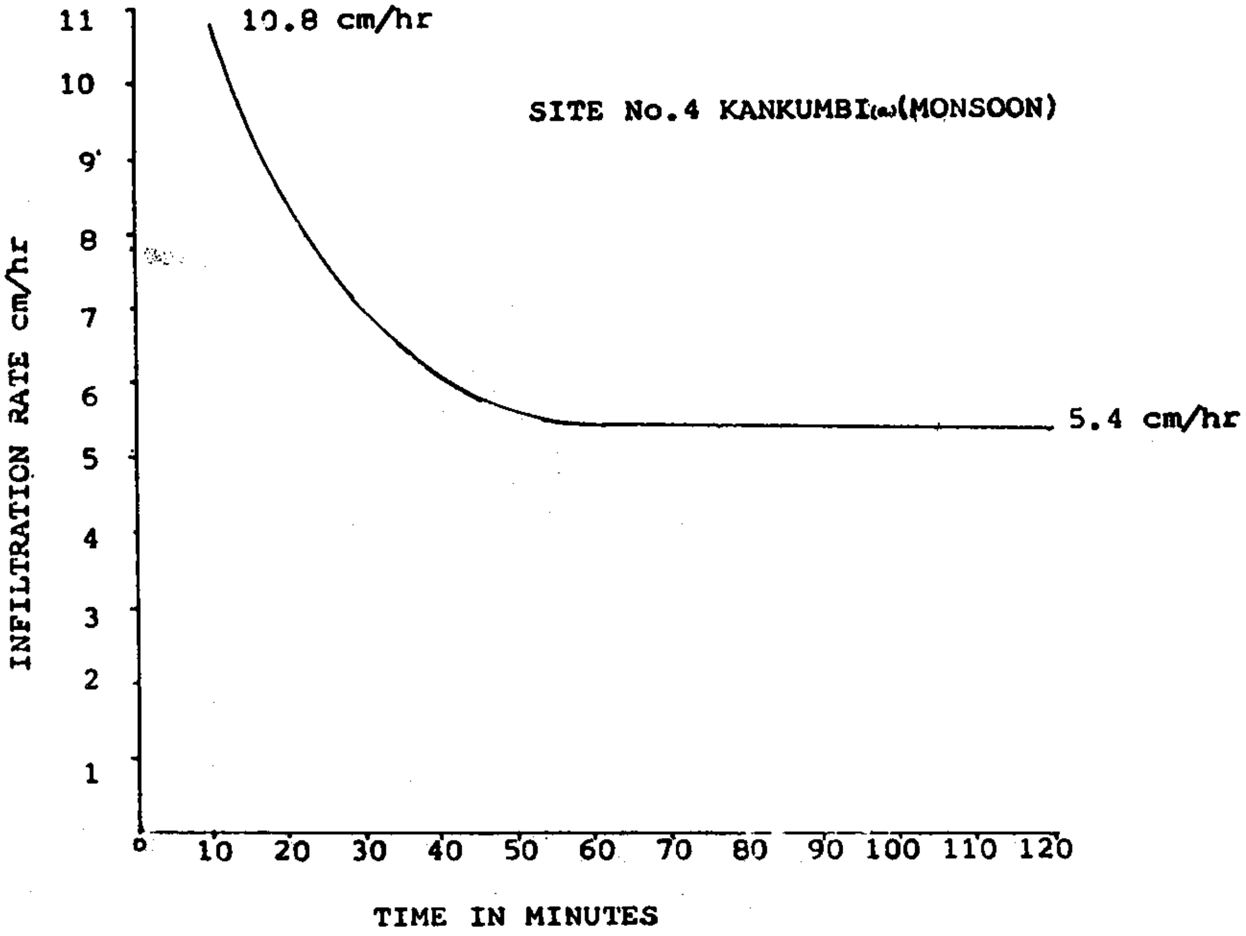



Fig.17. Infiltration curve at Kankumbi(a)site on forest land covered by sandy loam underlain by basalt.

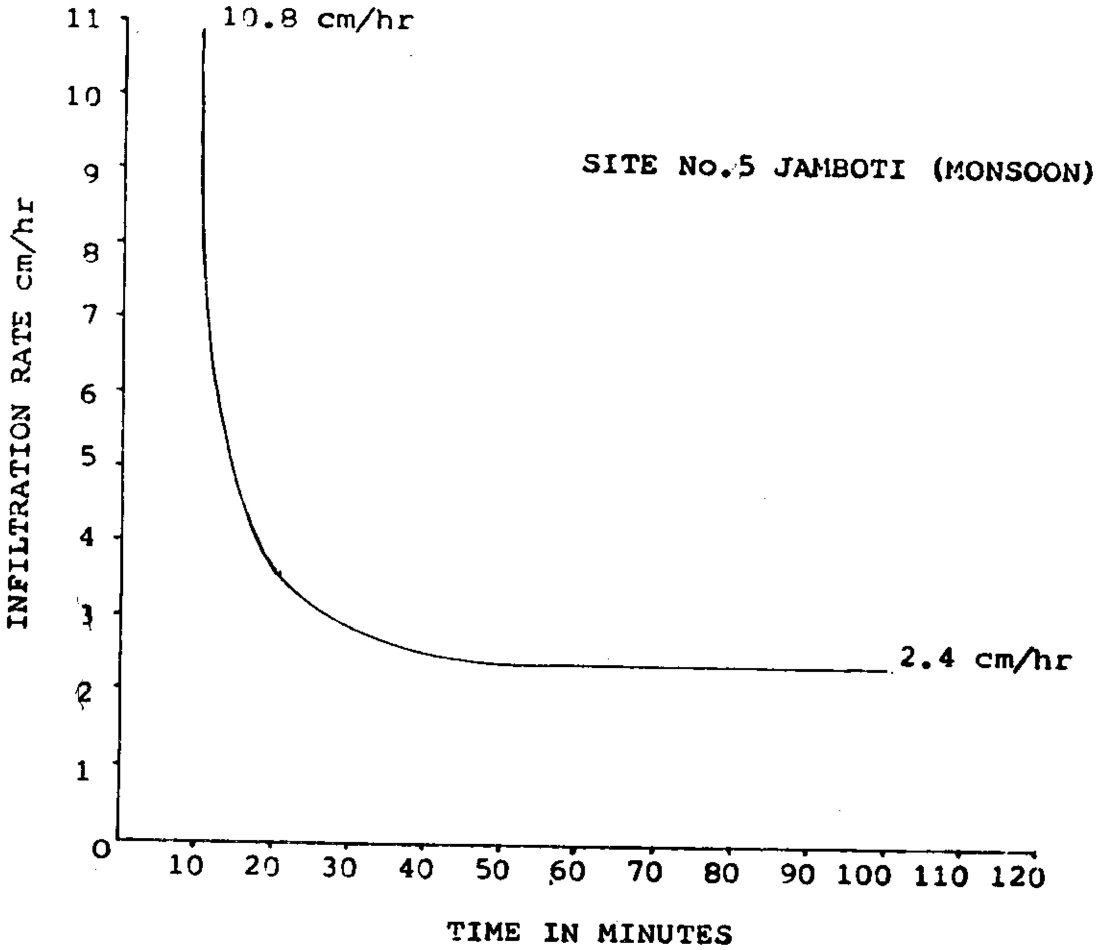



Fig:18. Infiltration curve at Jamboti site on agricultural land covered by medium loam soil and underlain by basalt.

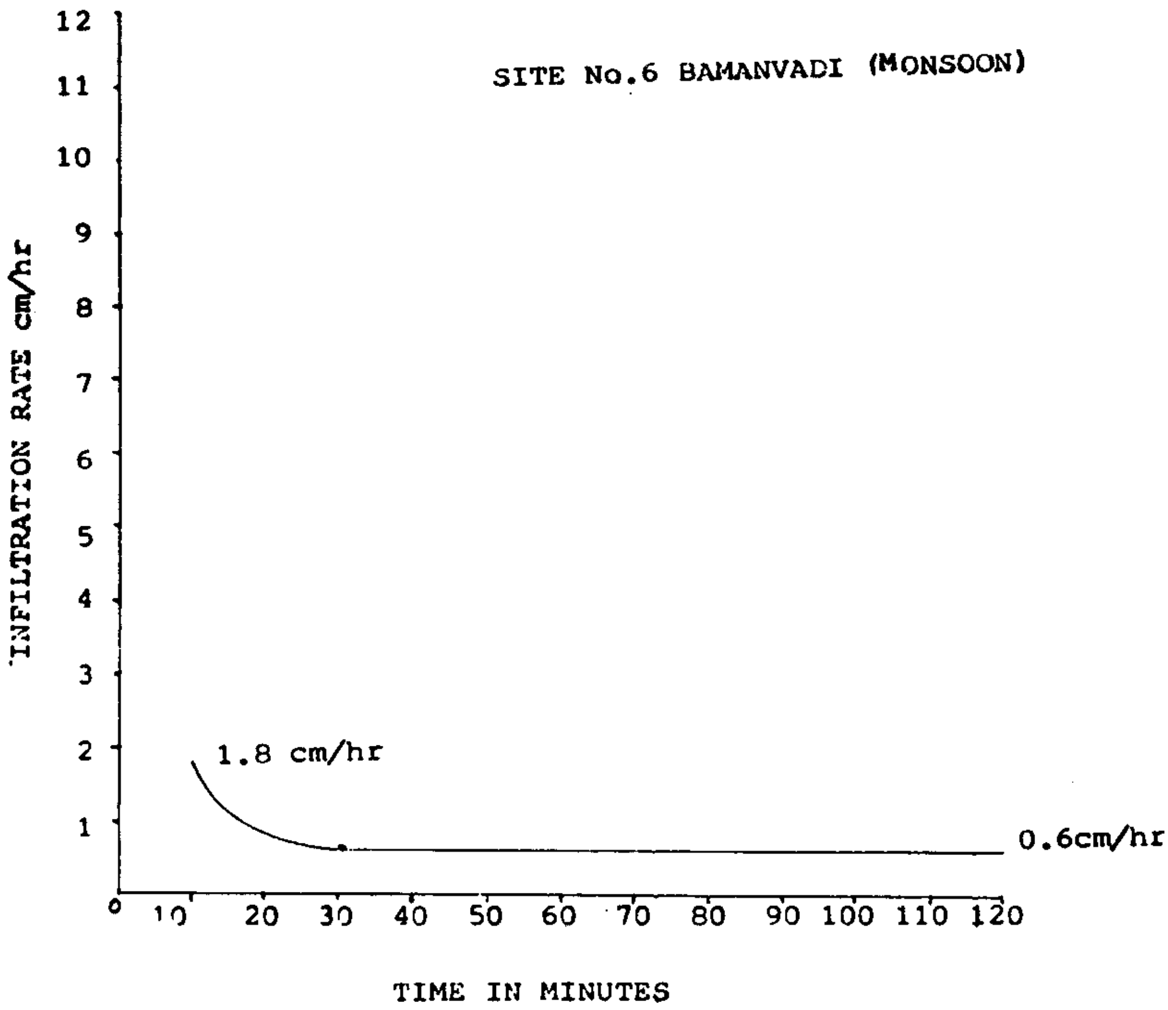



Fig:19. Infiltration curve at Bamanvadi on agricultural land covered by heavy loam soil and underlain by basalt.

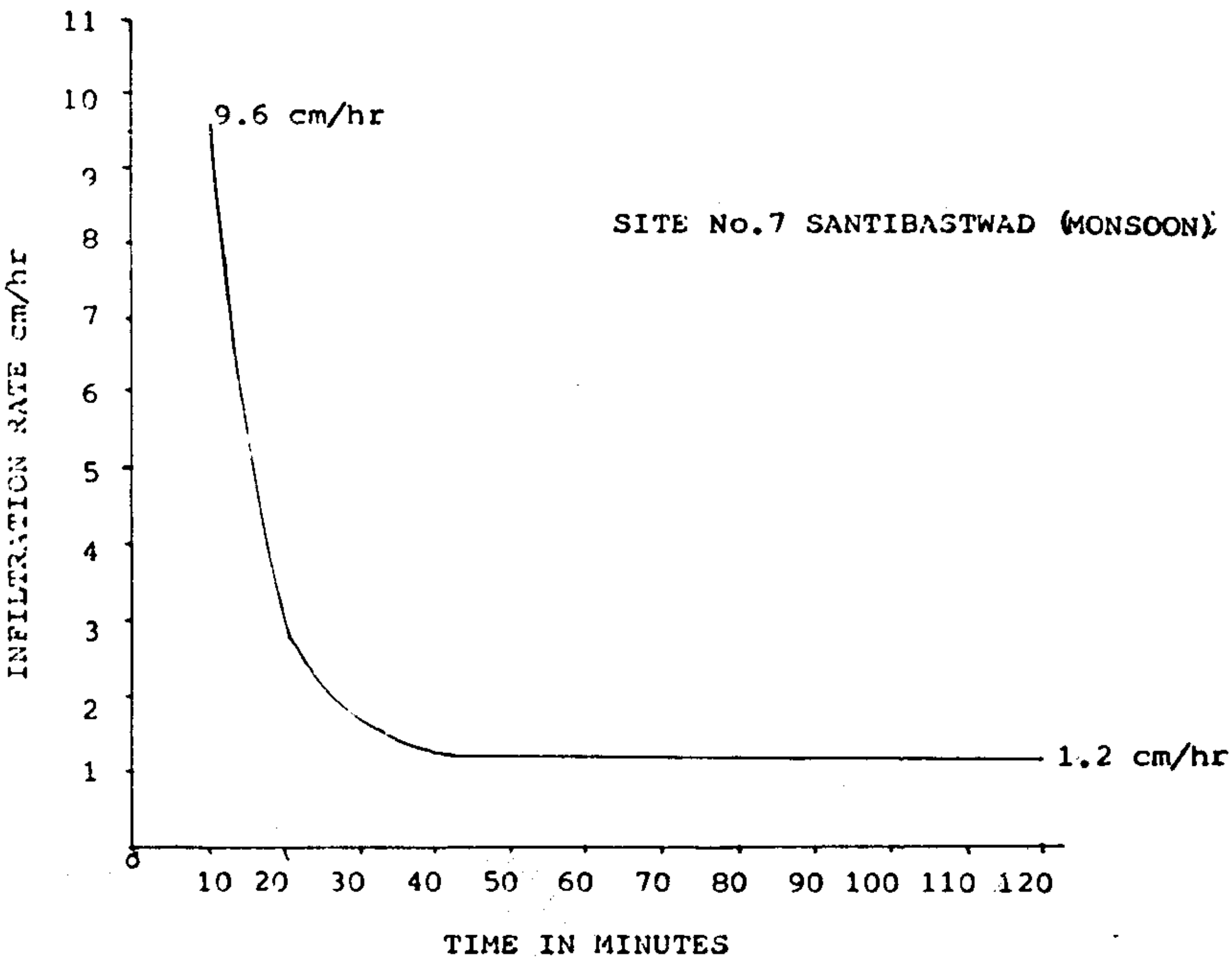



Fig:20. Infiltration curve at Santbastvad site on barren land covered by clayey soil and underlained by basalt.

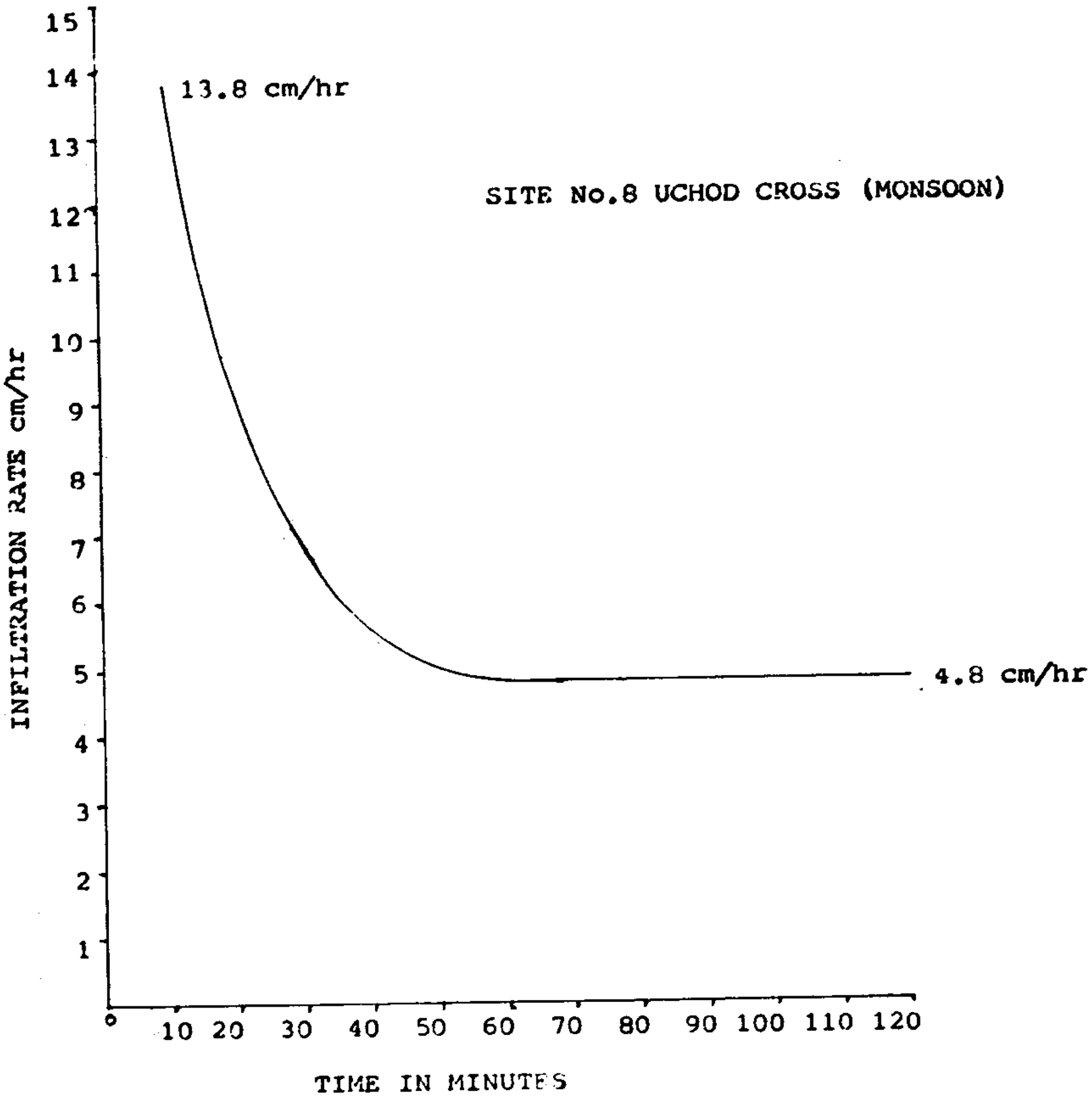



Fig:21. Infiltration curve at Uchod cross on forest land covered by clayey soil and underlained by basalt.

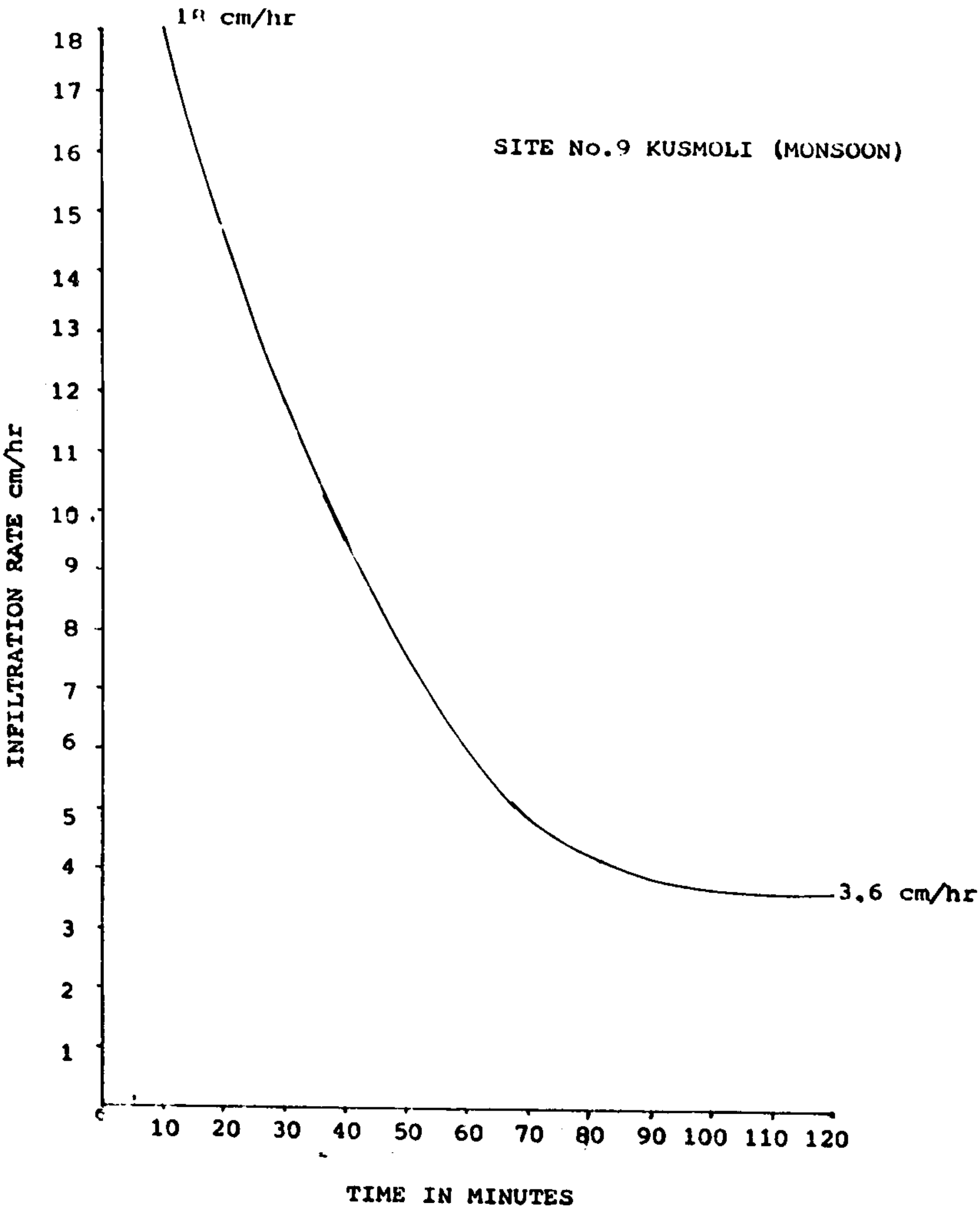



Fig:22. Infiltration curve at Kusmoli site on shrubby land covered by heavy loam and underlained by basalt.

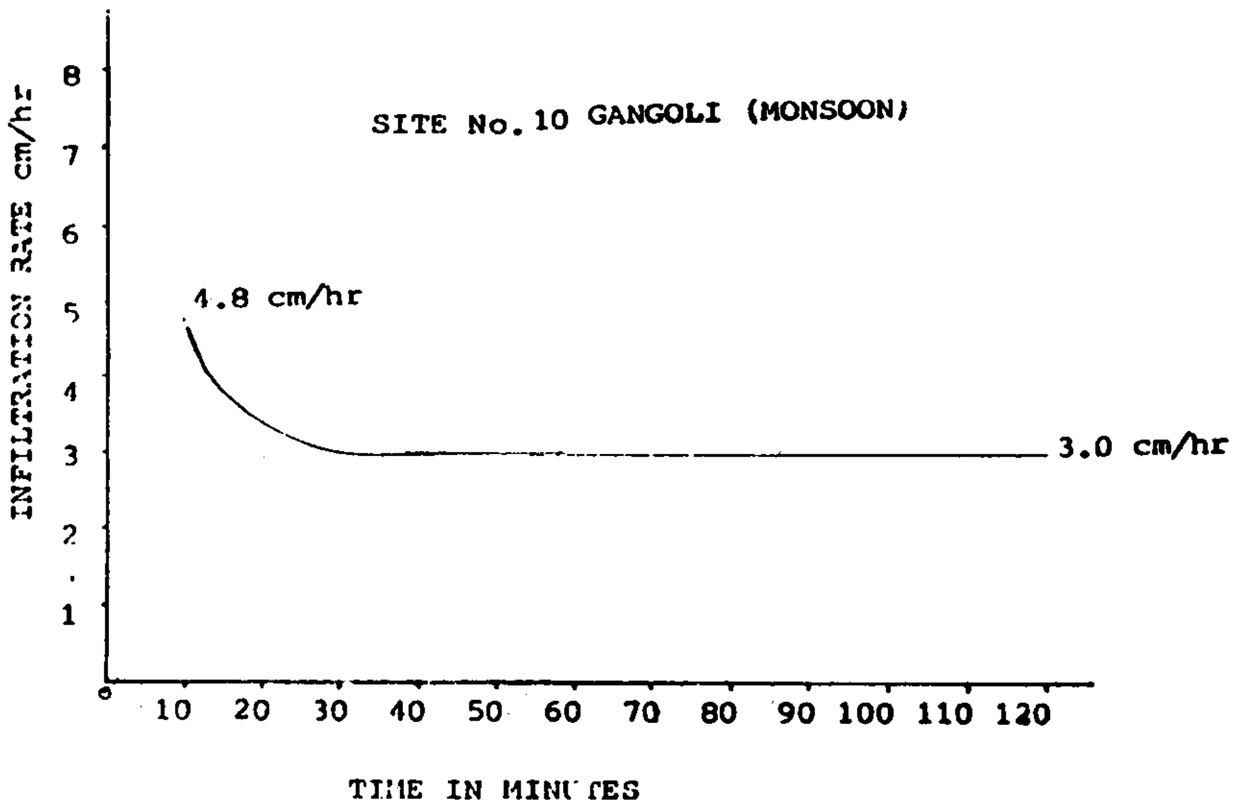
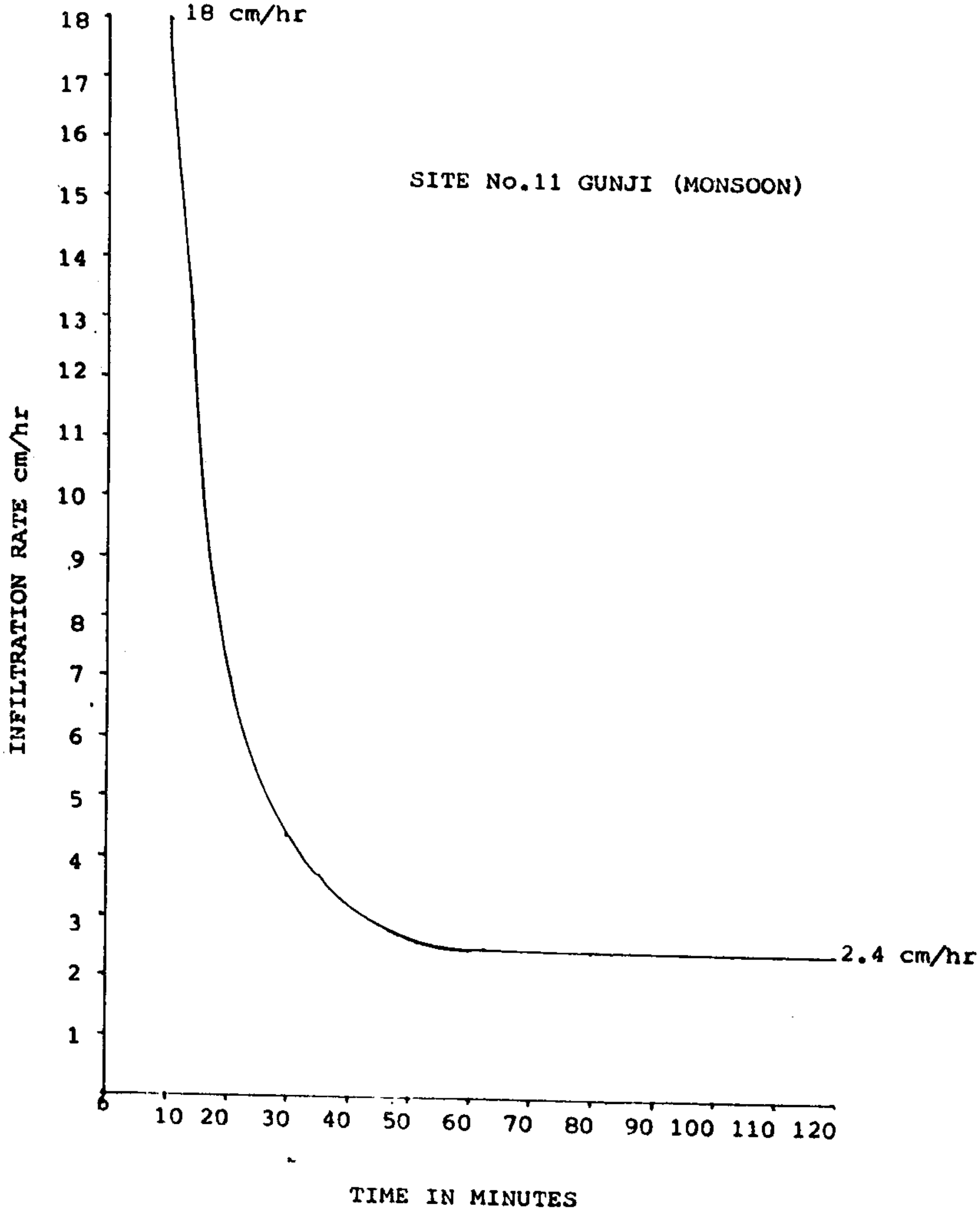



Fig:23. Infiltration curve at Gangoli site on forest land covered by light loam and underlain by basalt.




**Fig;24. Infiltration curve at Gunji site on agricultural land covered by heavy loam and underlain by sedimentry rock.**

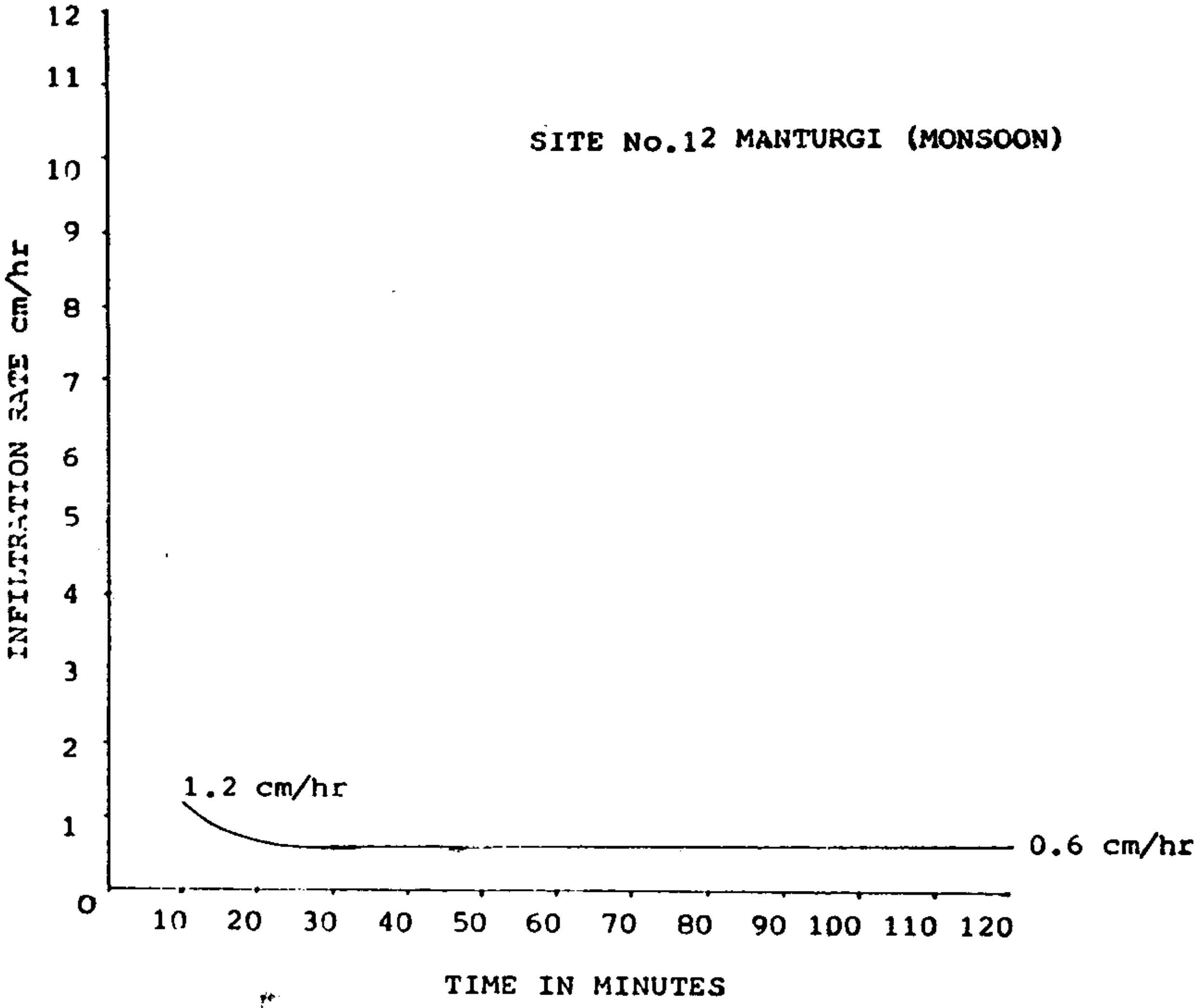



Fig:25. Infiltration curve at Manturgi site on agricultural land covered by medium loam and underlain by basalt.

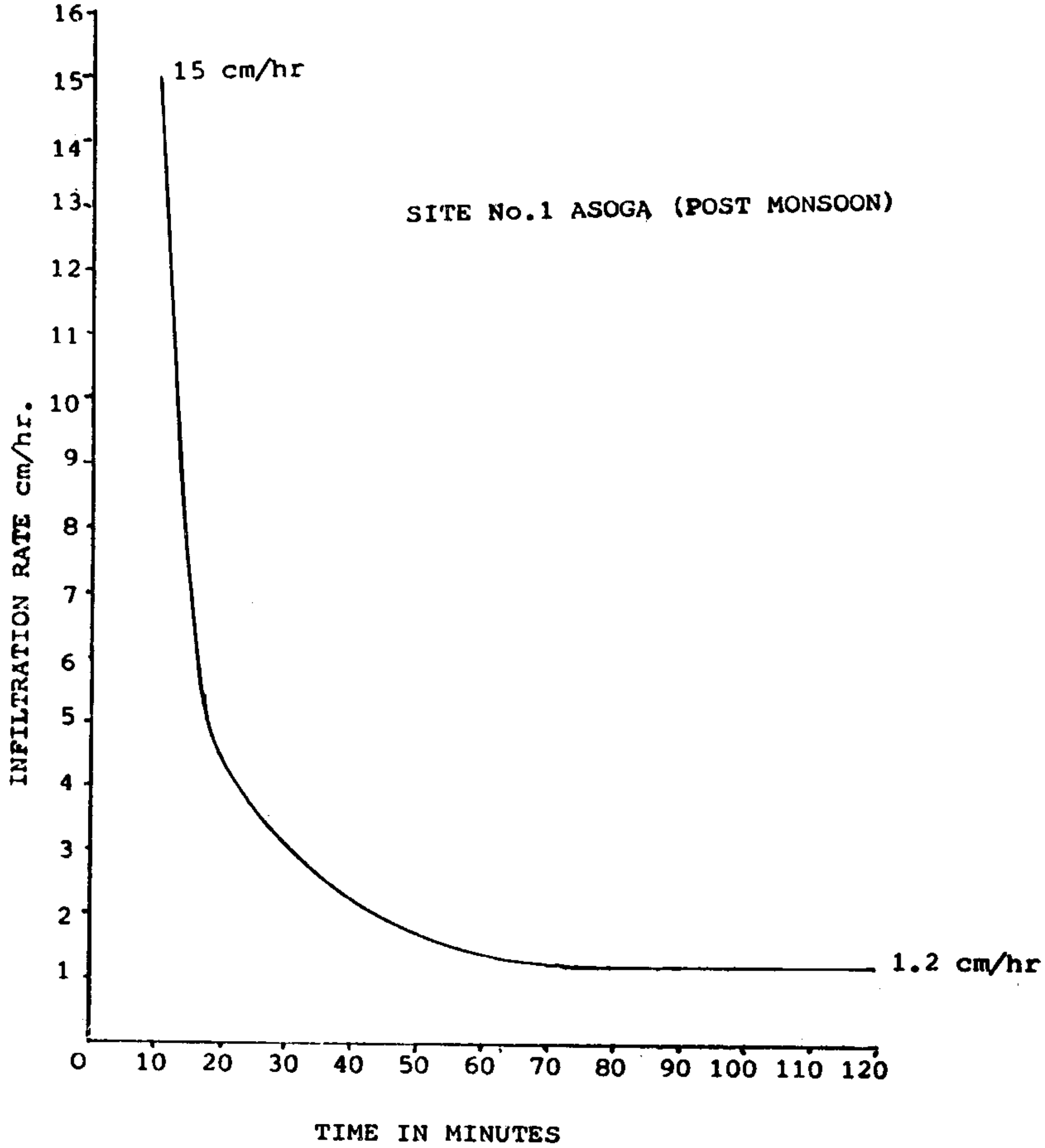



Fig:26. Infiltration curve at Asoga site on agricultural land covered by Heavy loam soil and underlain by basalt,

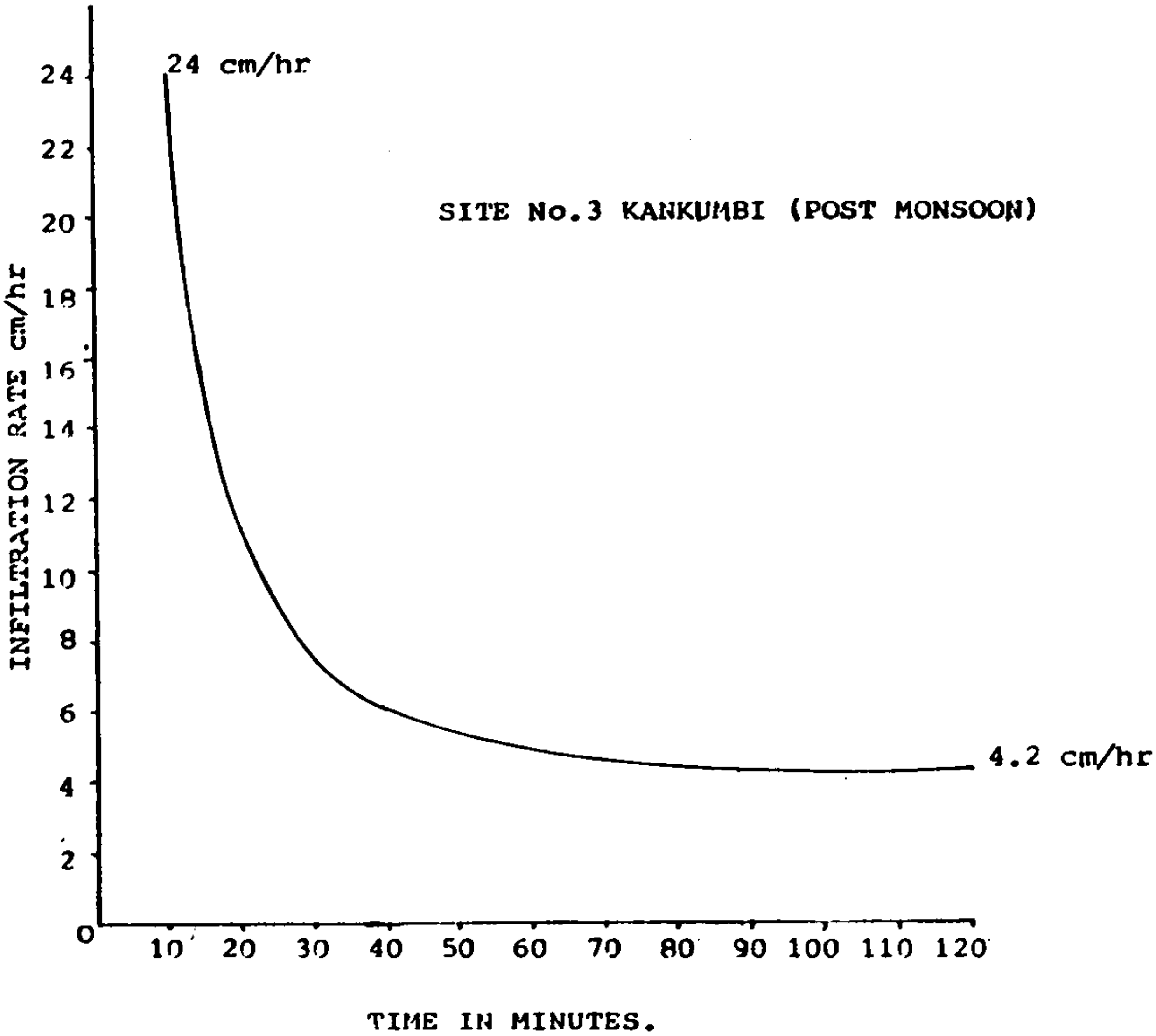
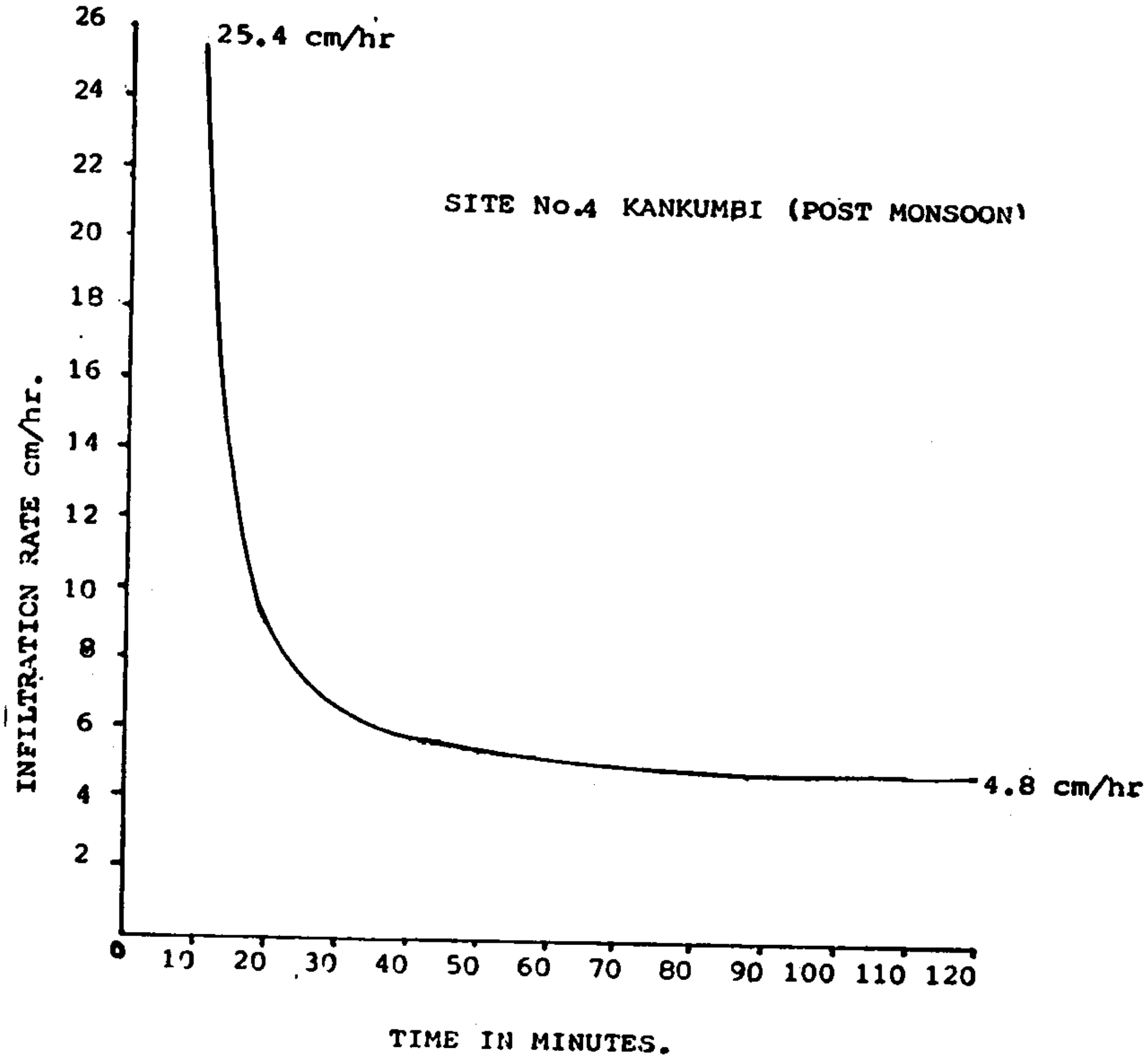



Fig: 27. Infiltration curve at Kankumbi site on barren land covered by sandy loam soil and underlain by basalt.




Fig; 28. Infiltration curve at Kankumbi (a) site on forest land covered by sandy loam underlain by basalt.

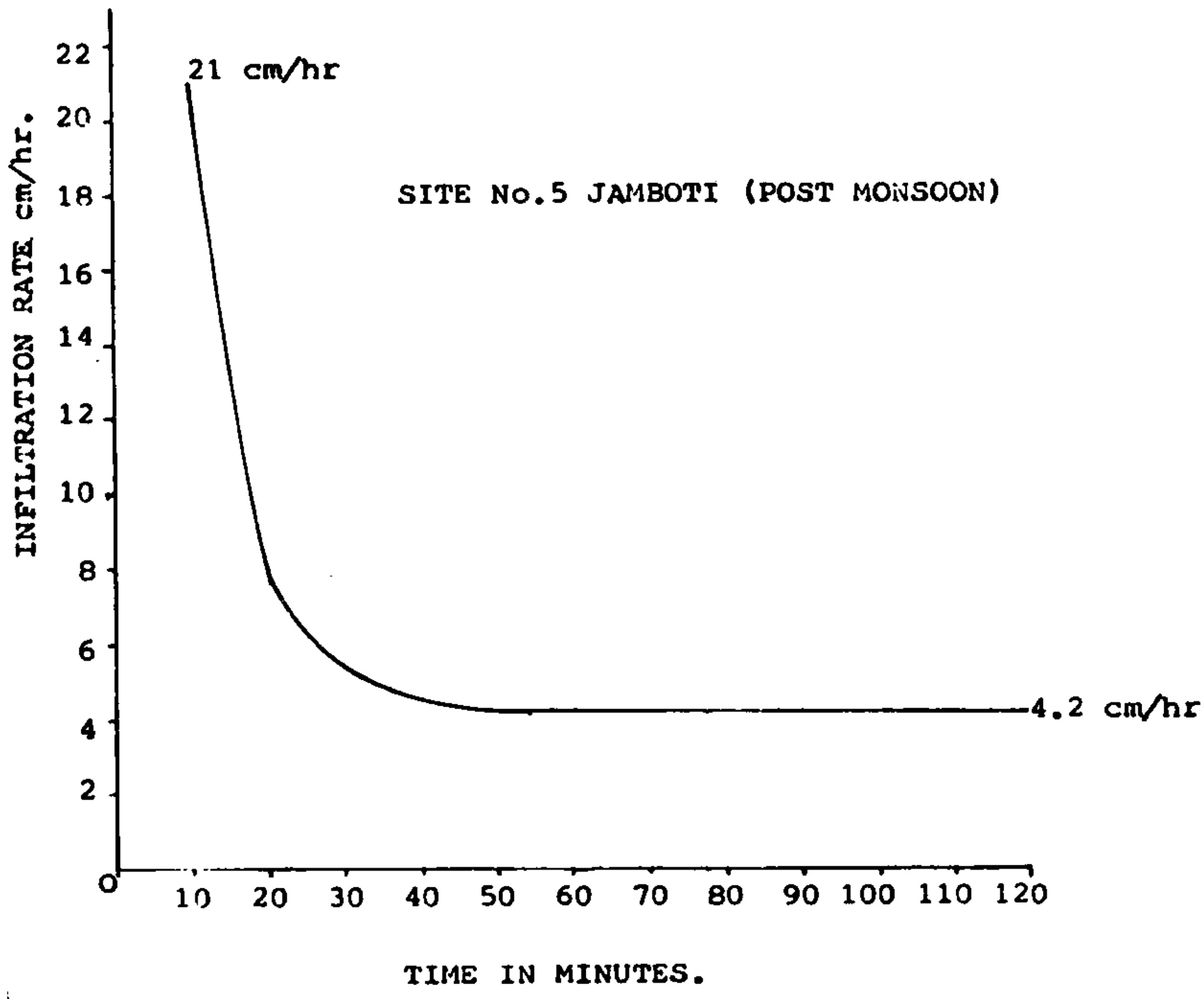



**Fig: 29. Infiltration curve at Jamboti site on agricultural land covered by medium loam soil and underlain by basalt.**

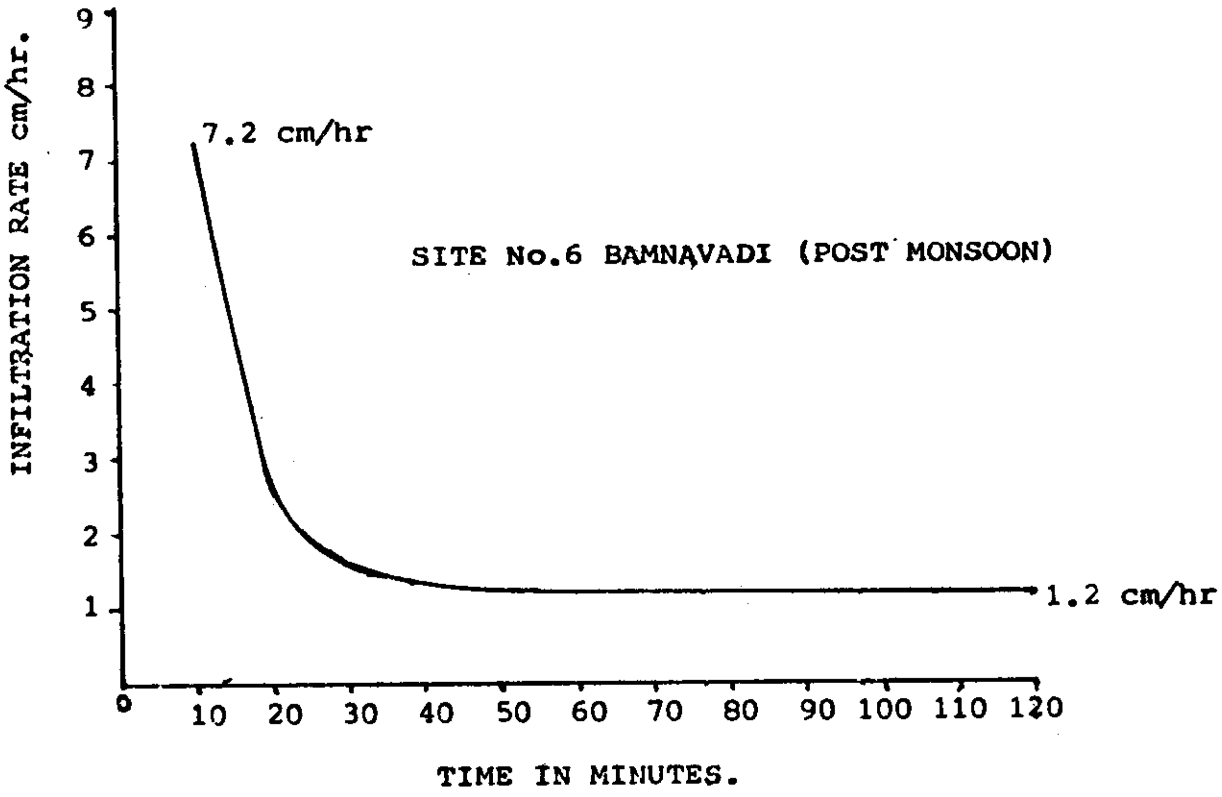



Fig:30. Infiltration curve at Bamanvadi on agricultural land covered by heavy loam soil and underlain by basalt.

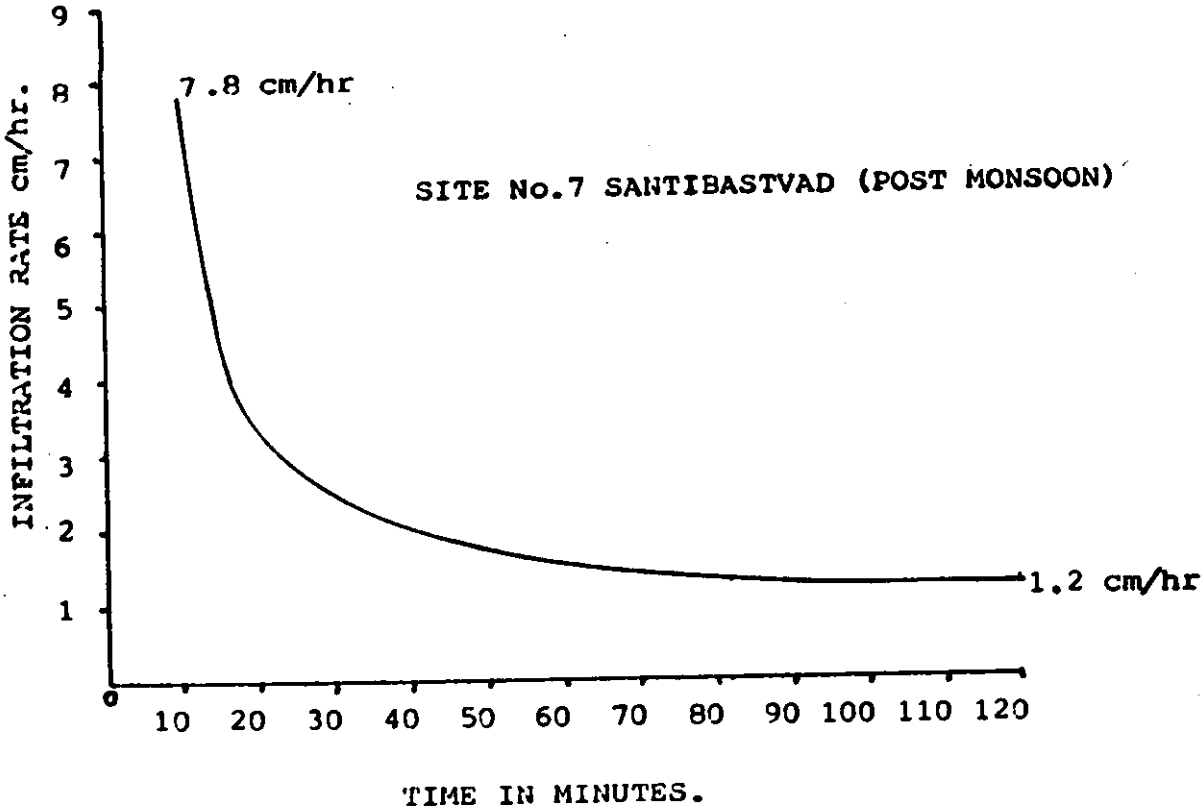



Fig:31. Infiltration curve at Santbastvad site on barren land covered by clayey soil and underlain by basalt.

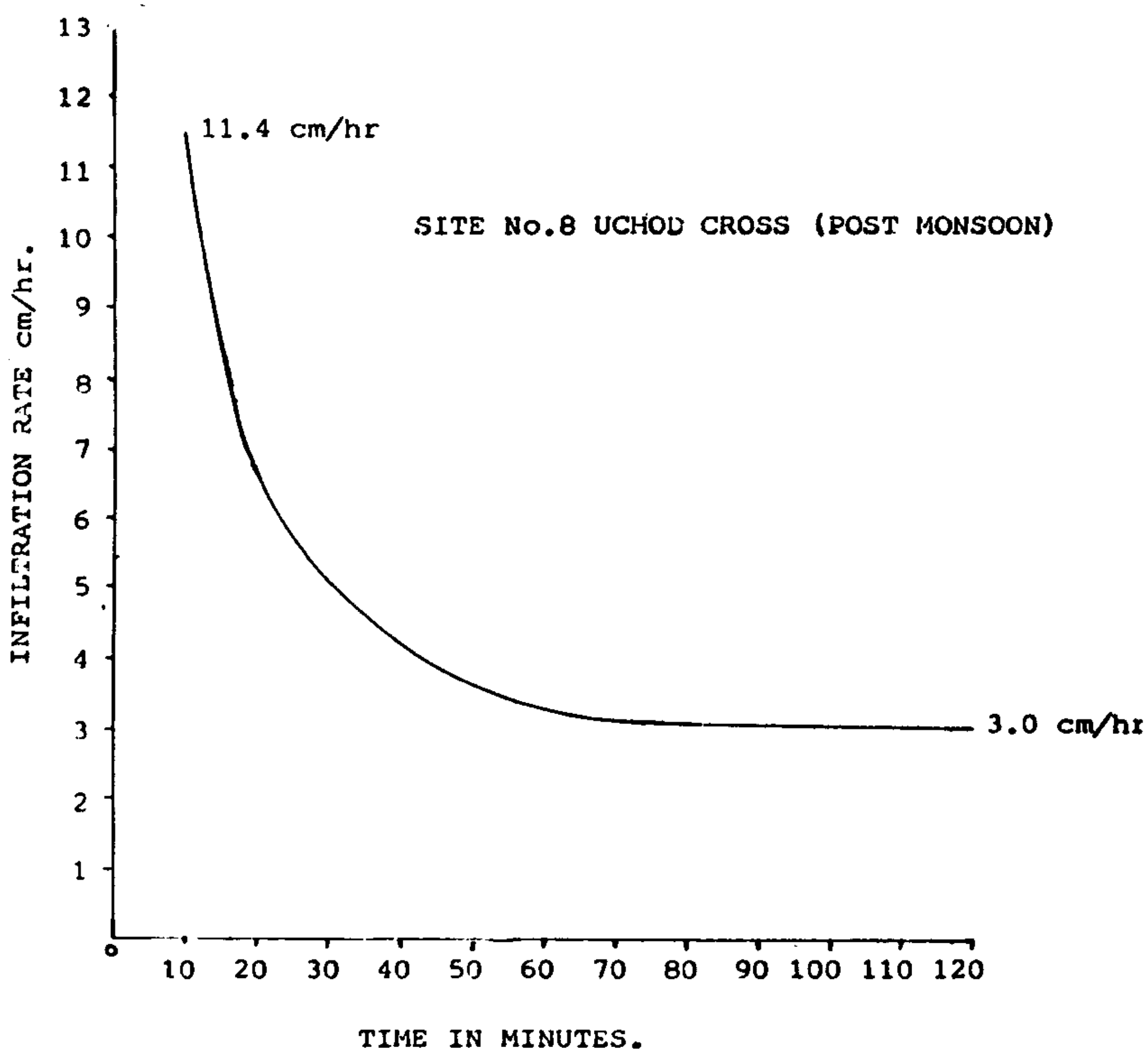



Fig 32. Infiltration curve at Uchod cross on forest land covered by clayey soil and underlain by basalt.

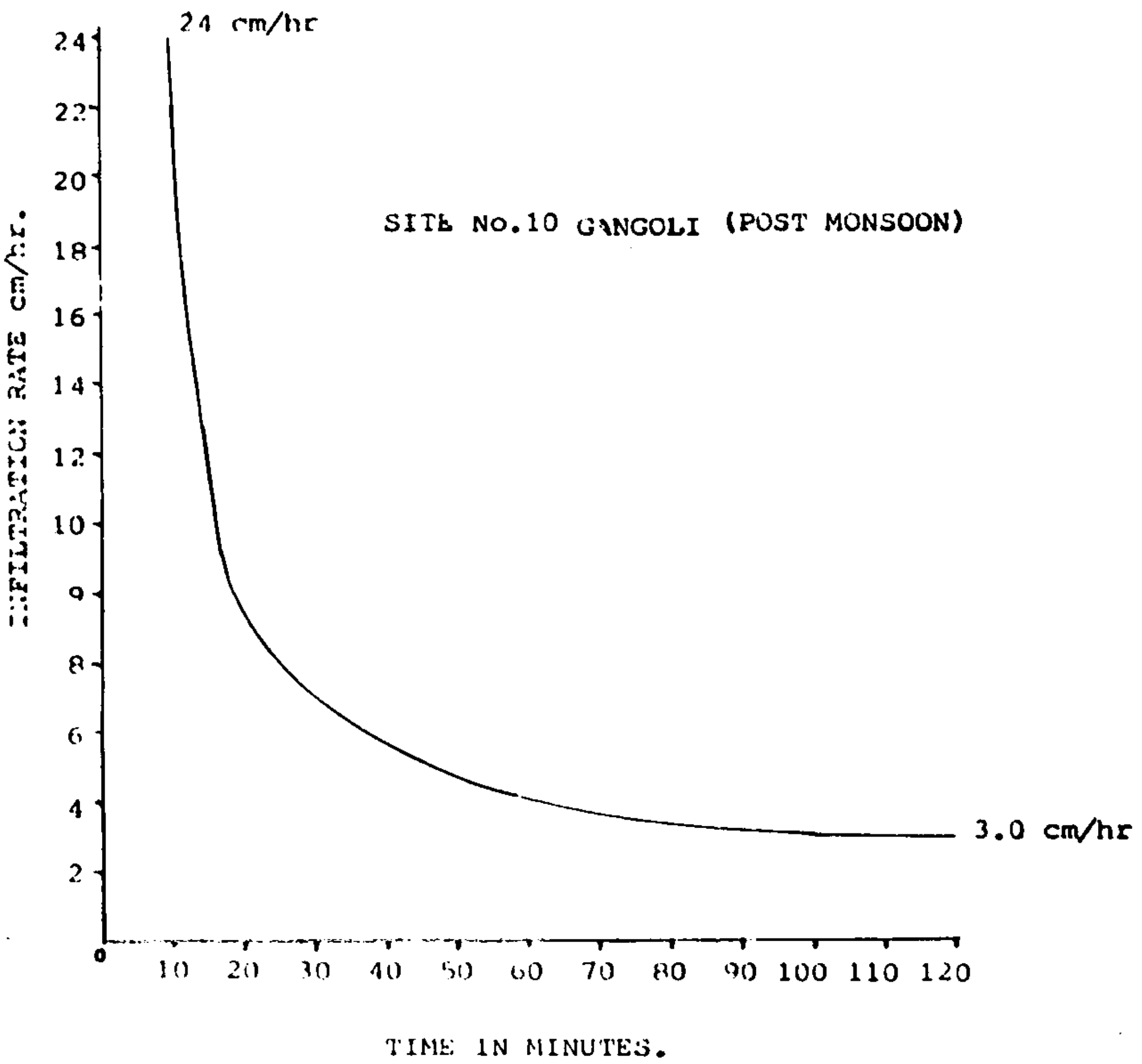



Fig:33. Infiltration curve at Gangoli site on forest land covered by light loam soil and underlain by basalt

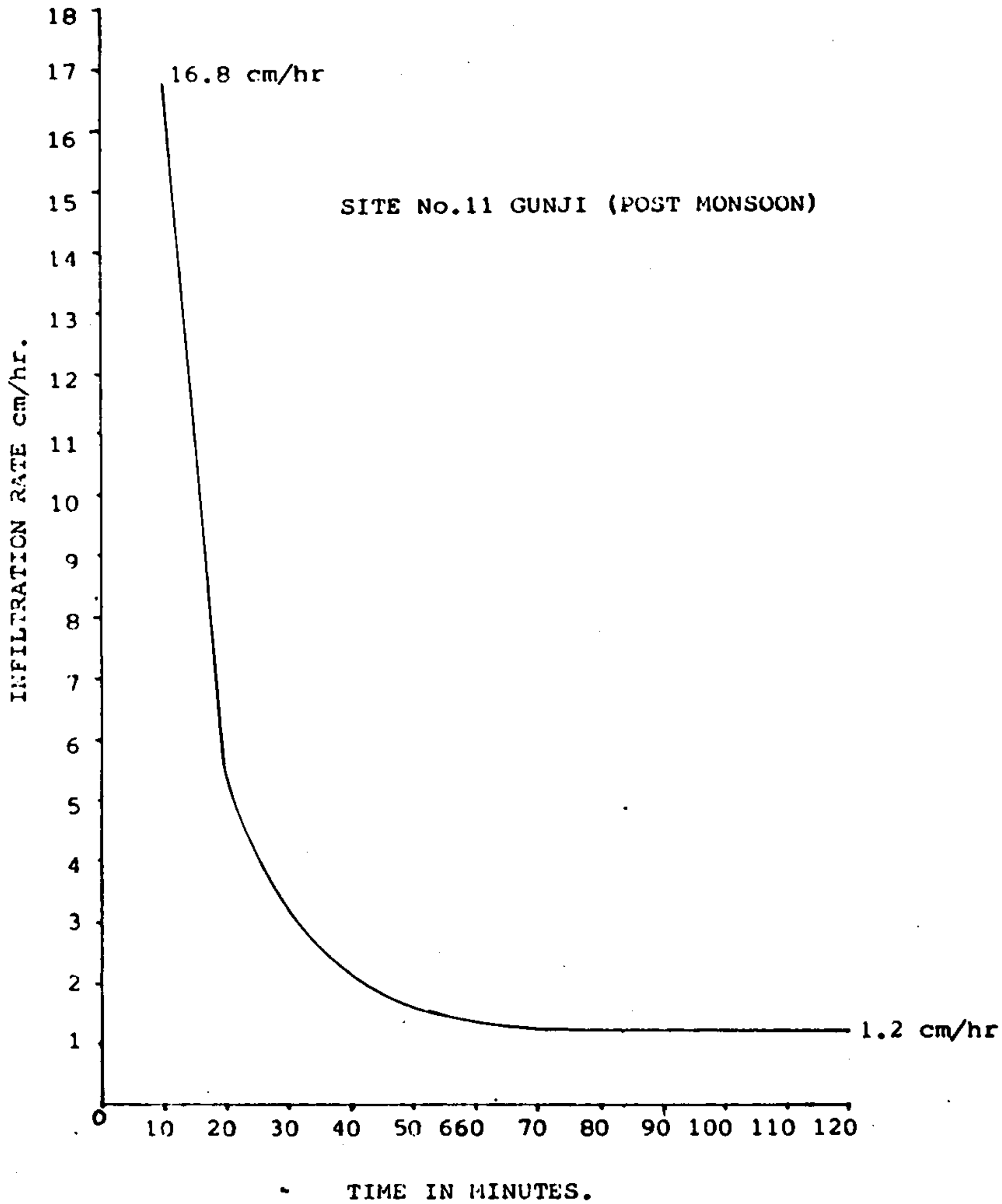



Fig:34 Infiltration curve at Gunji site on agricultural land covered by heavy loam soil and underlain by sedimentry rock.

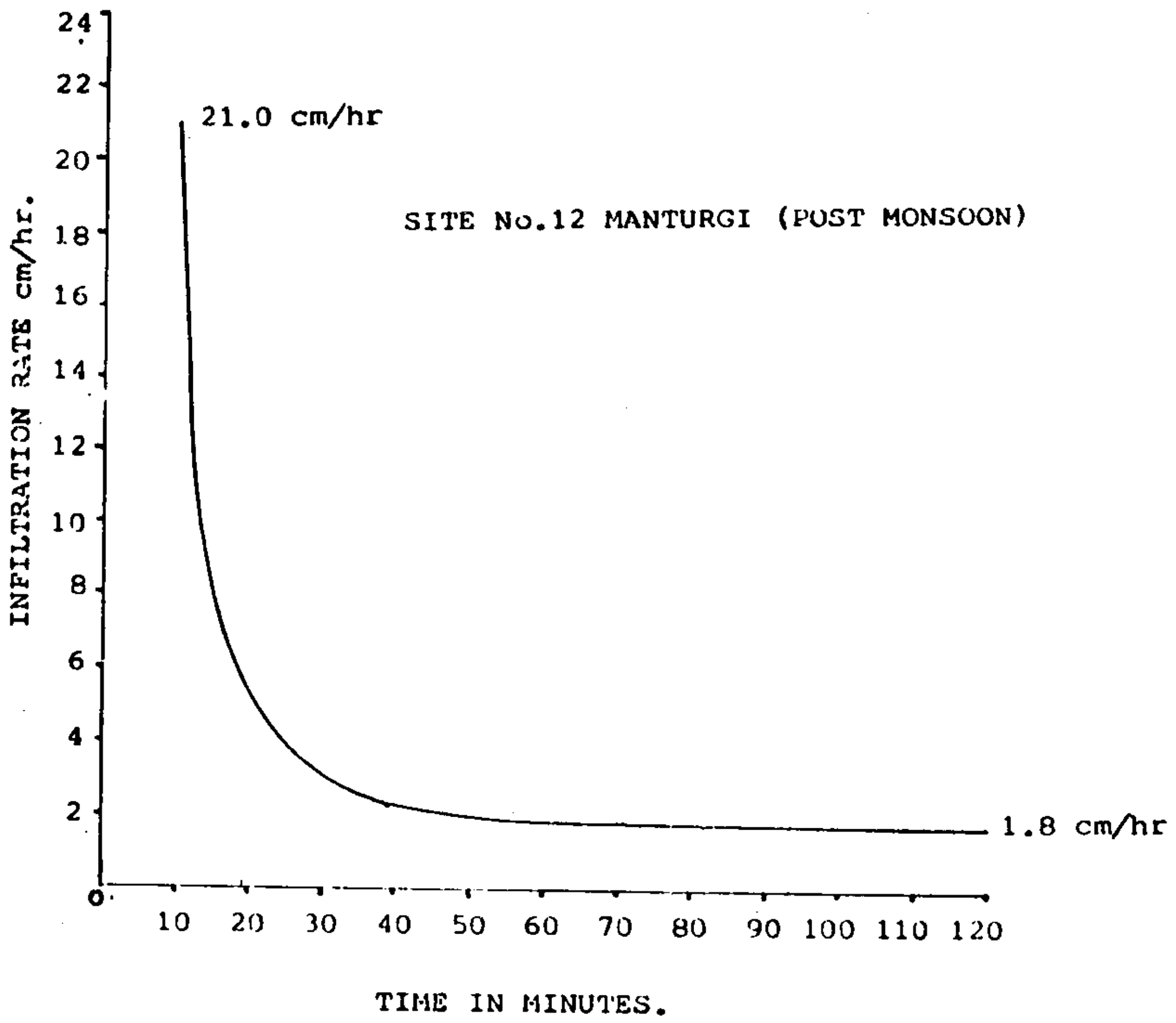



Fig:35. Infiltration curve at Manturgi site on agricultural land covered by medium loam soil and underlain by basalt.

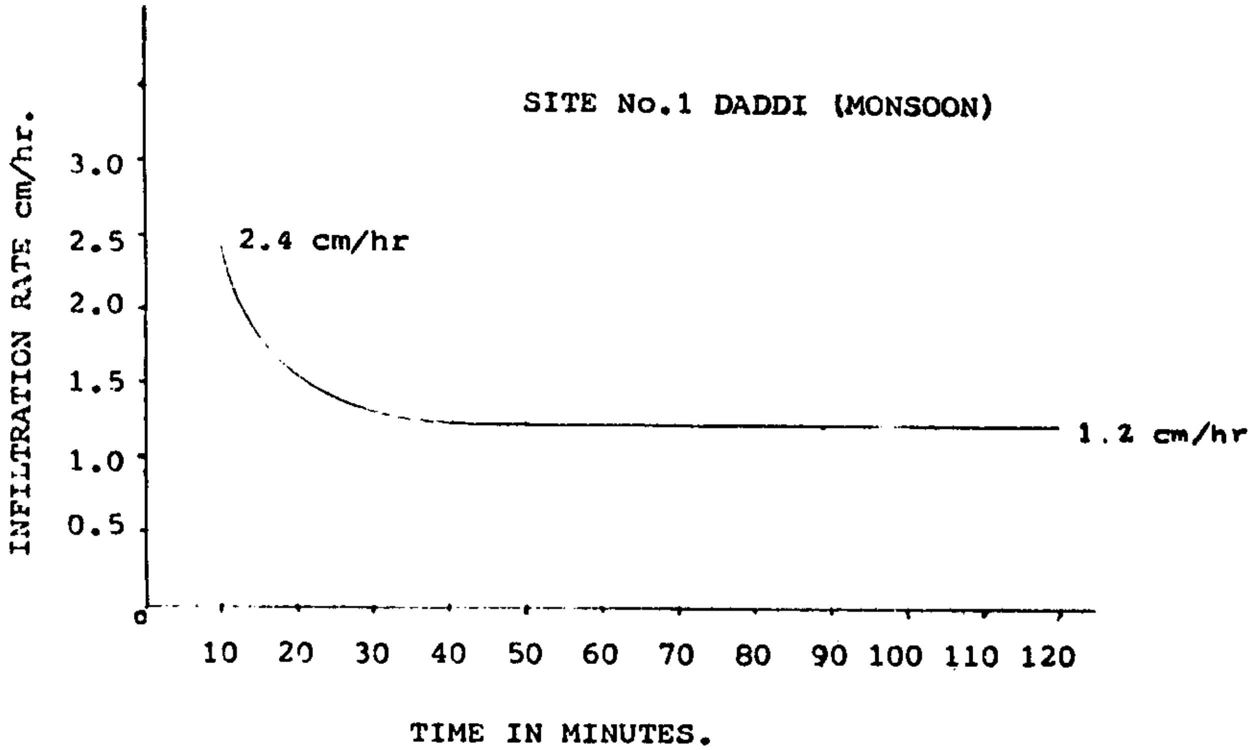



Fig:36 Infiltration curve at Daddi site on agricultural land covered by heavy loam soil and underlain by basalt.

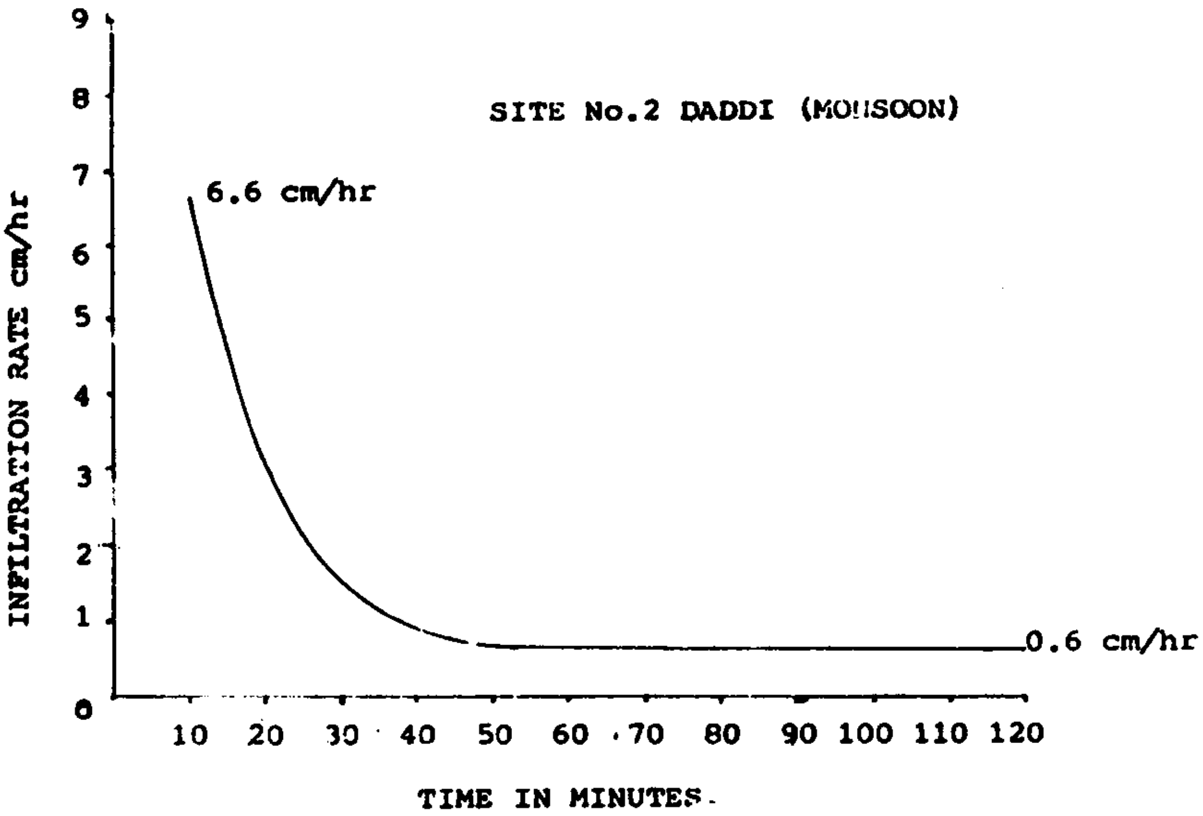



Fig: 37 Infiltration curve at Daddi (a) site on abandoned land covered by medium loam soil and underlain by basalt.

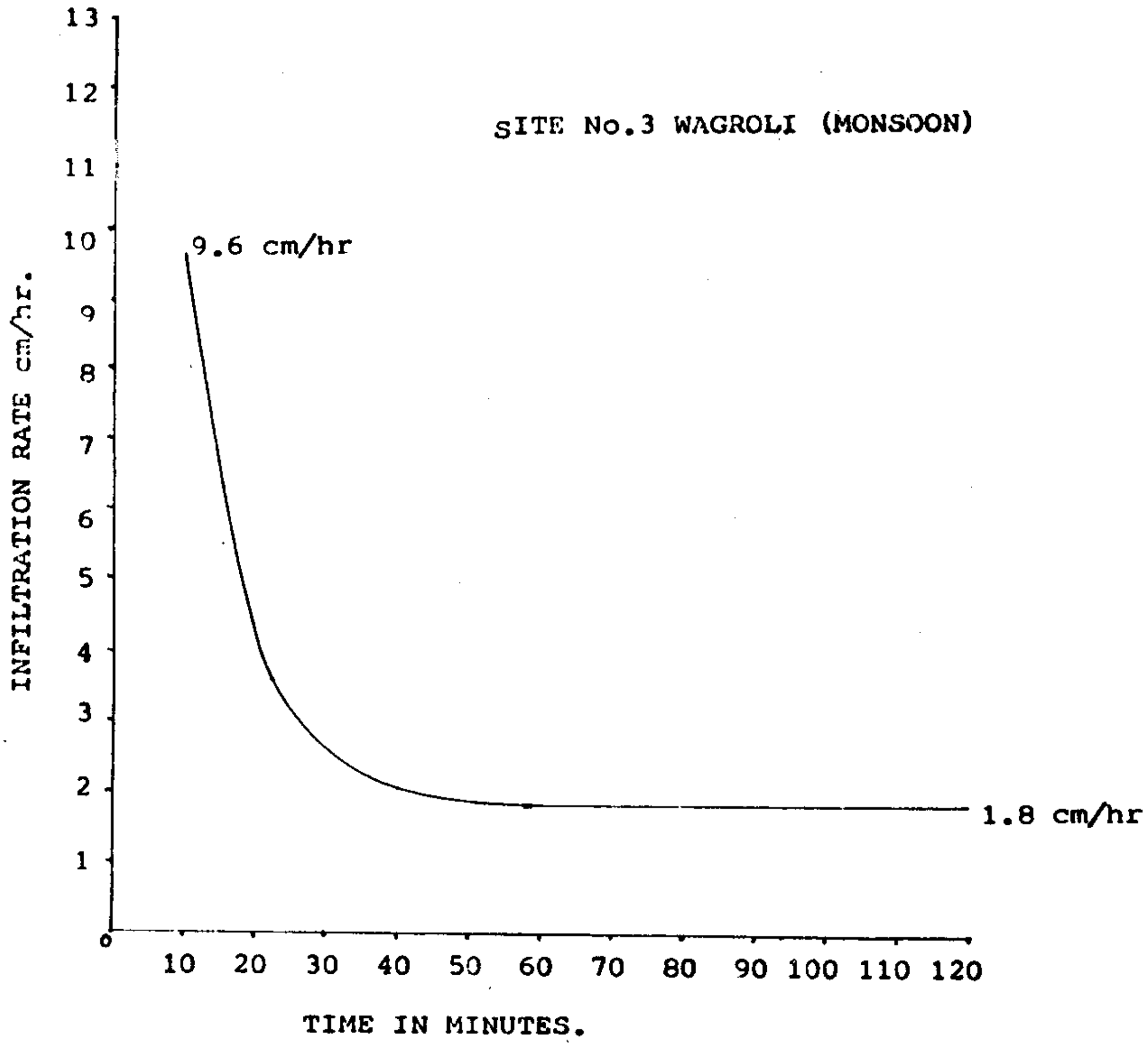



Fig:38. Infiltration curve at Wagholi site on barren land covered by medium loam soil and underlain by basalt.

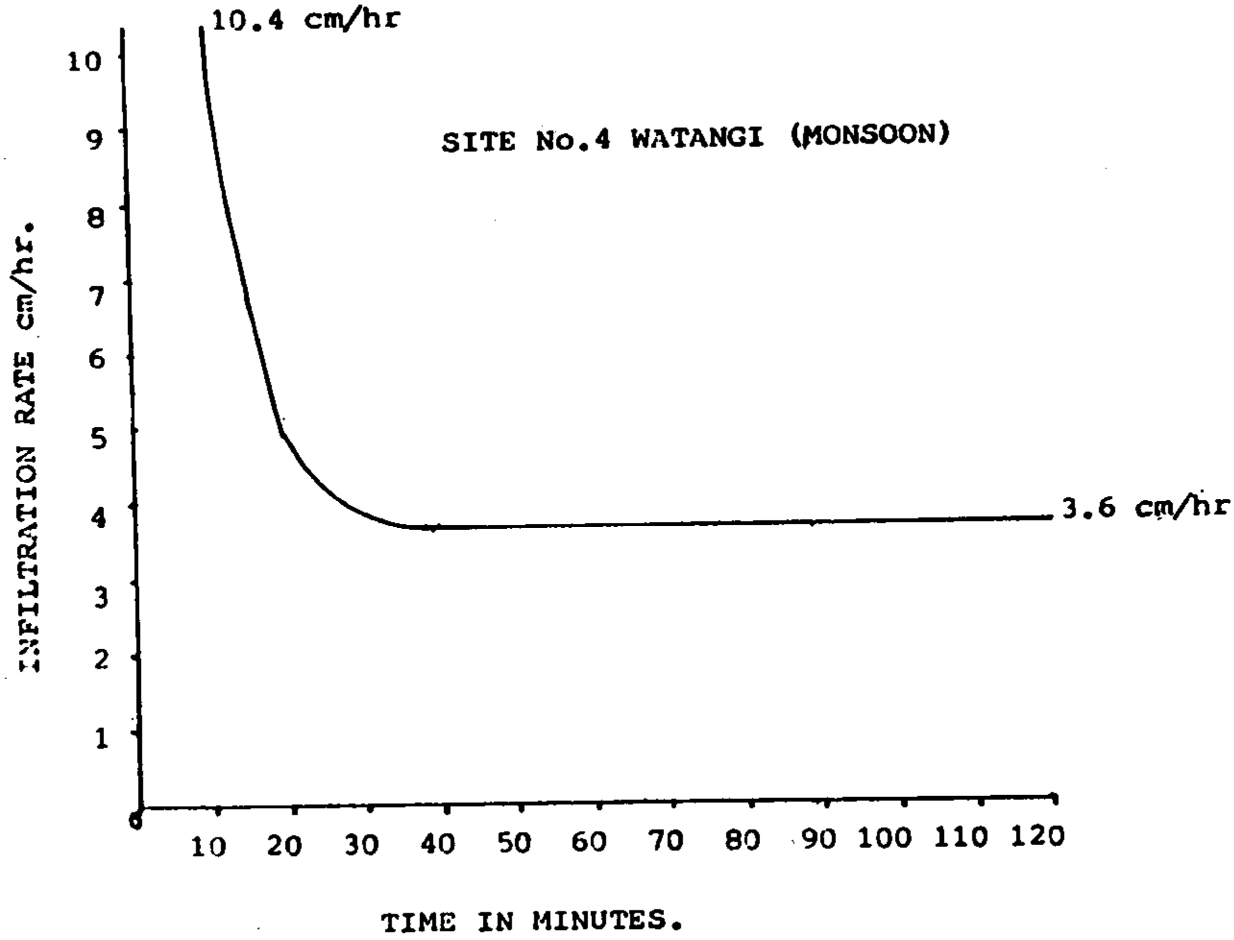



Fig:39. Infiltration curve at Watangi site on shrubby land covered by medium loam soil and underlained by basalt.

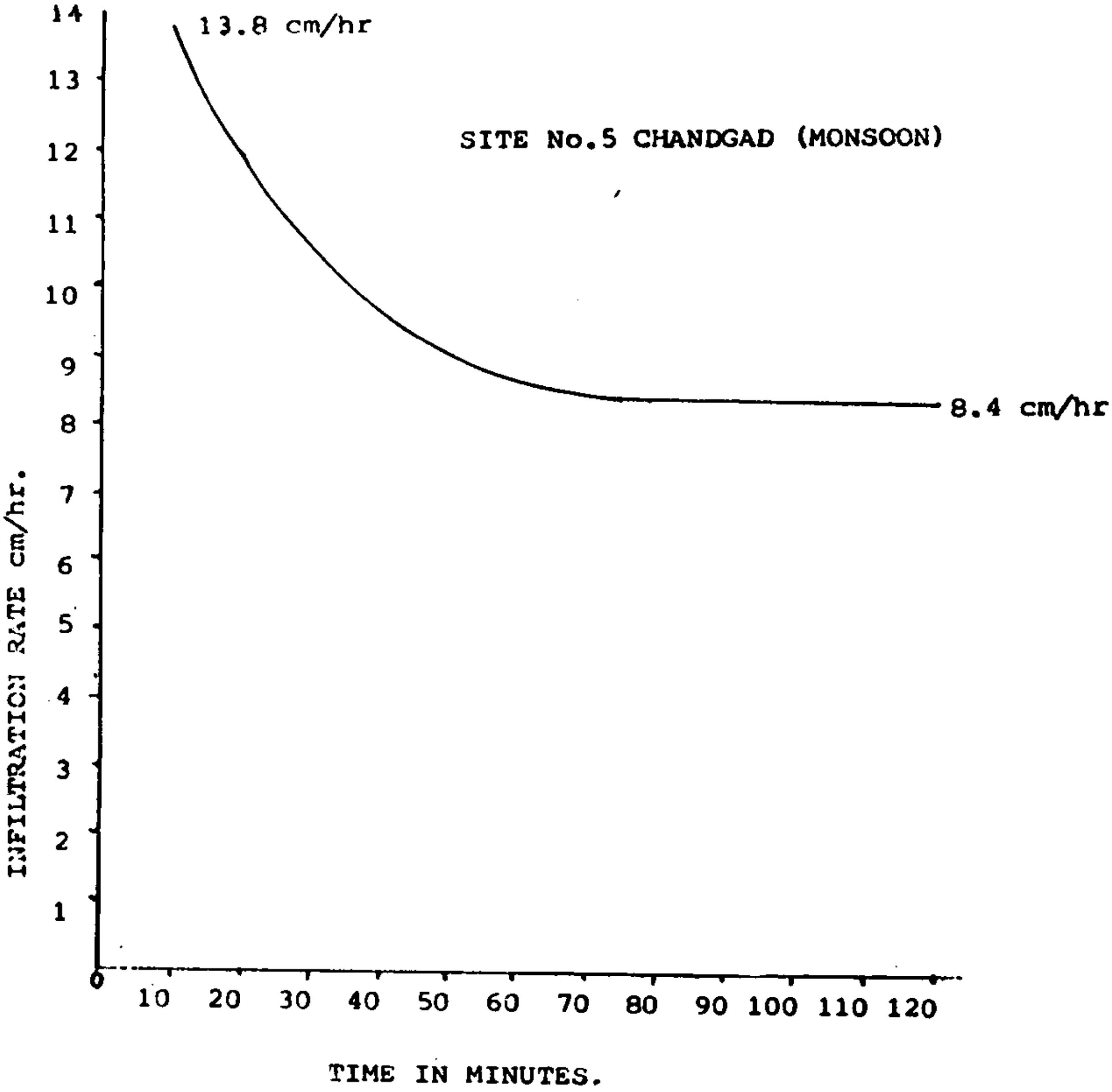



Fig:40. Infiltration curve at Chandgad site on shrubby land covered by light loam soil and underlain by basalt;

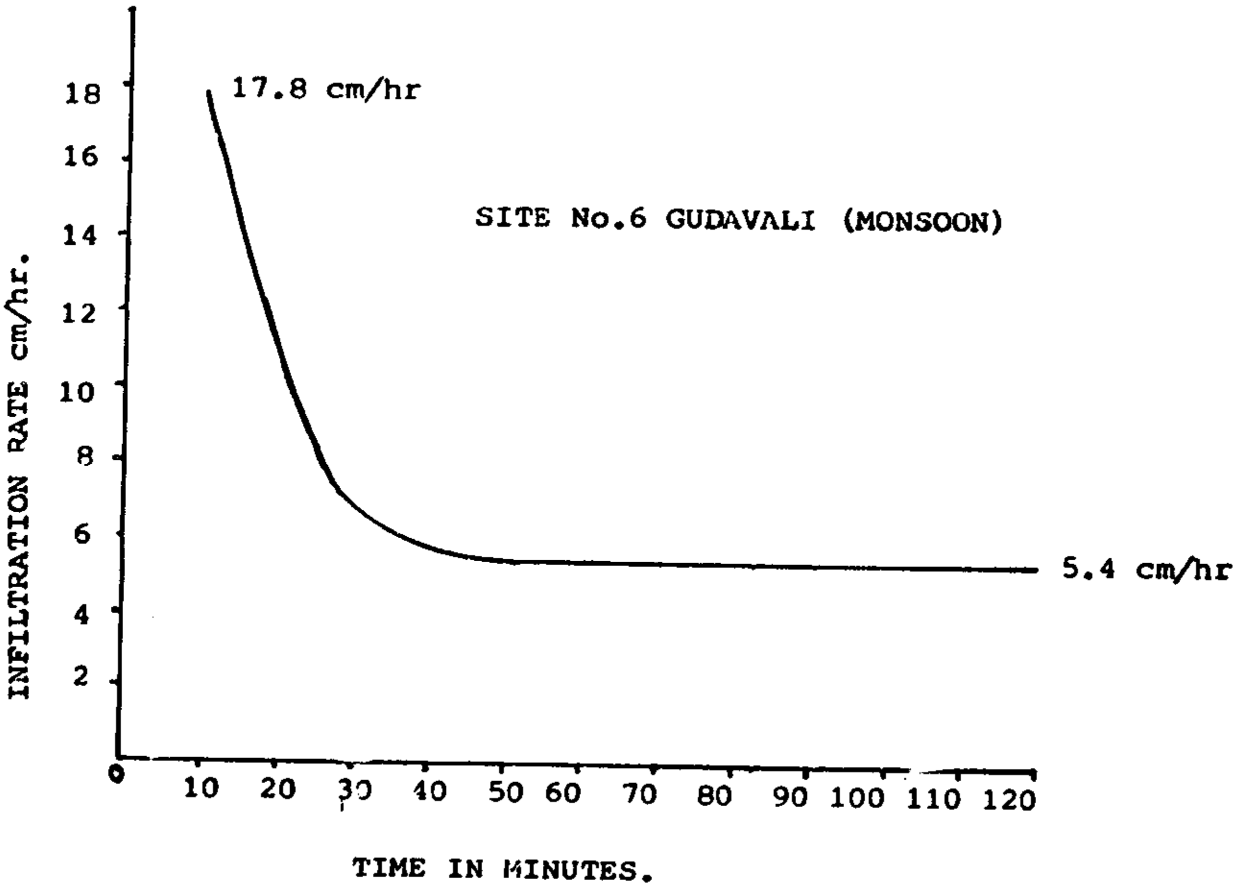



Fig:41. Infiltration curve at Gudavali site on agricultural land covered by light loam and underlain by basalt.

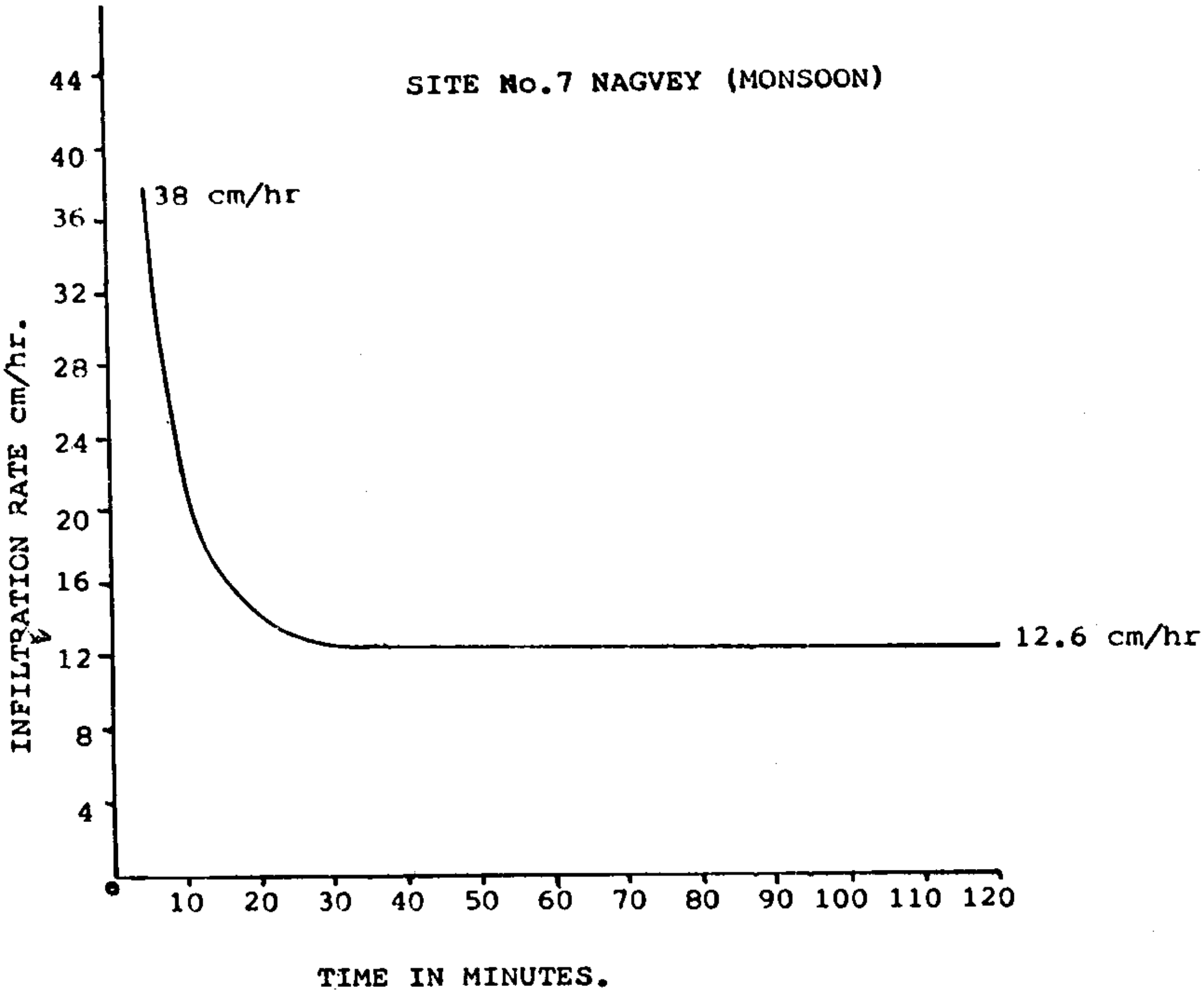



Fig:42. Infiltration curve at Nagvey site on forest land covered by heavy loam soil and underlain by basalt.

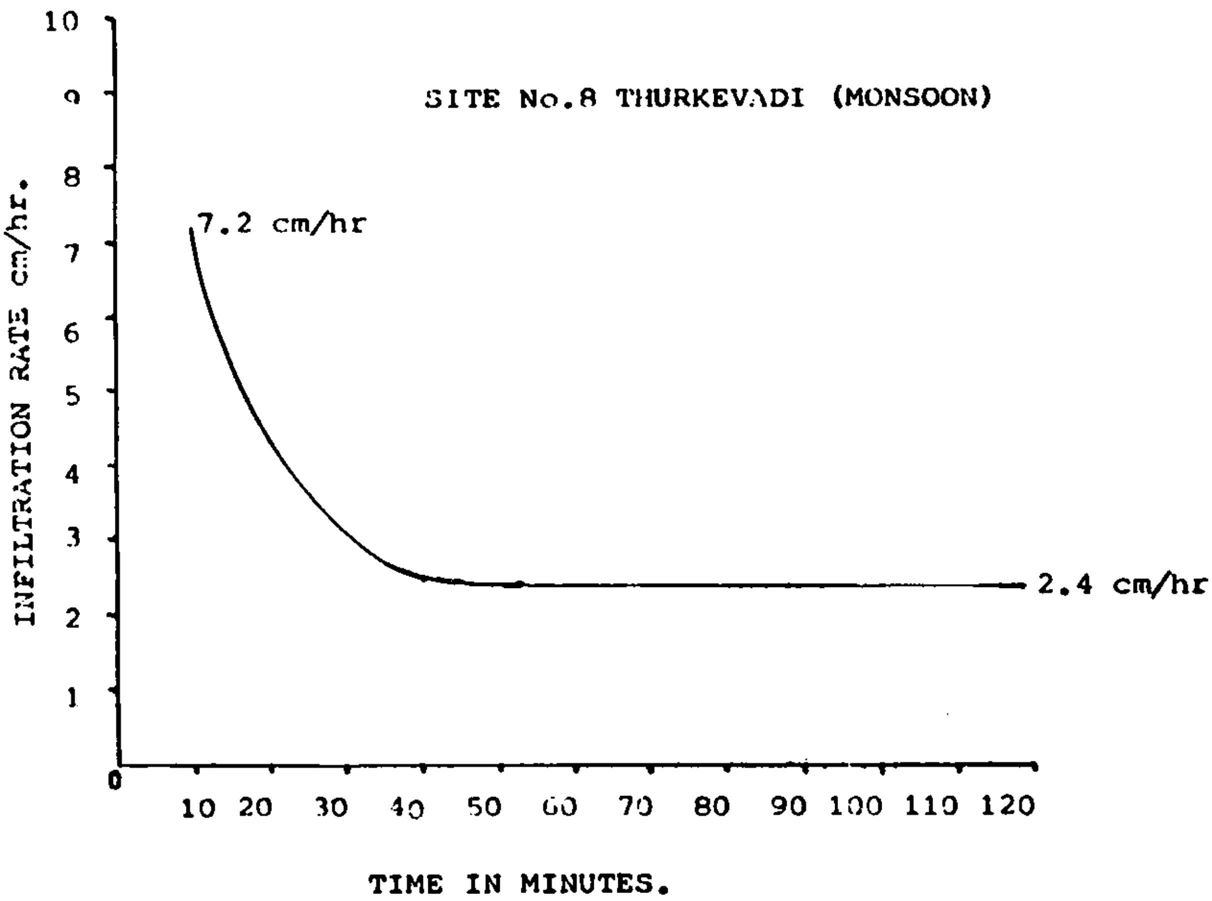



Fig: 43. Infiltration curve at Thurkevadi on agricultural land covered by medium loam soil and underlain by basalt.

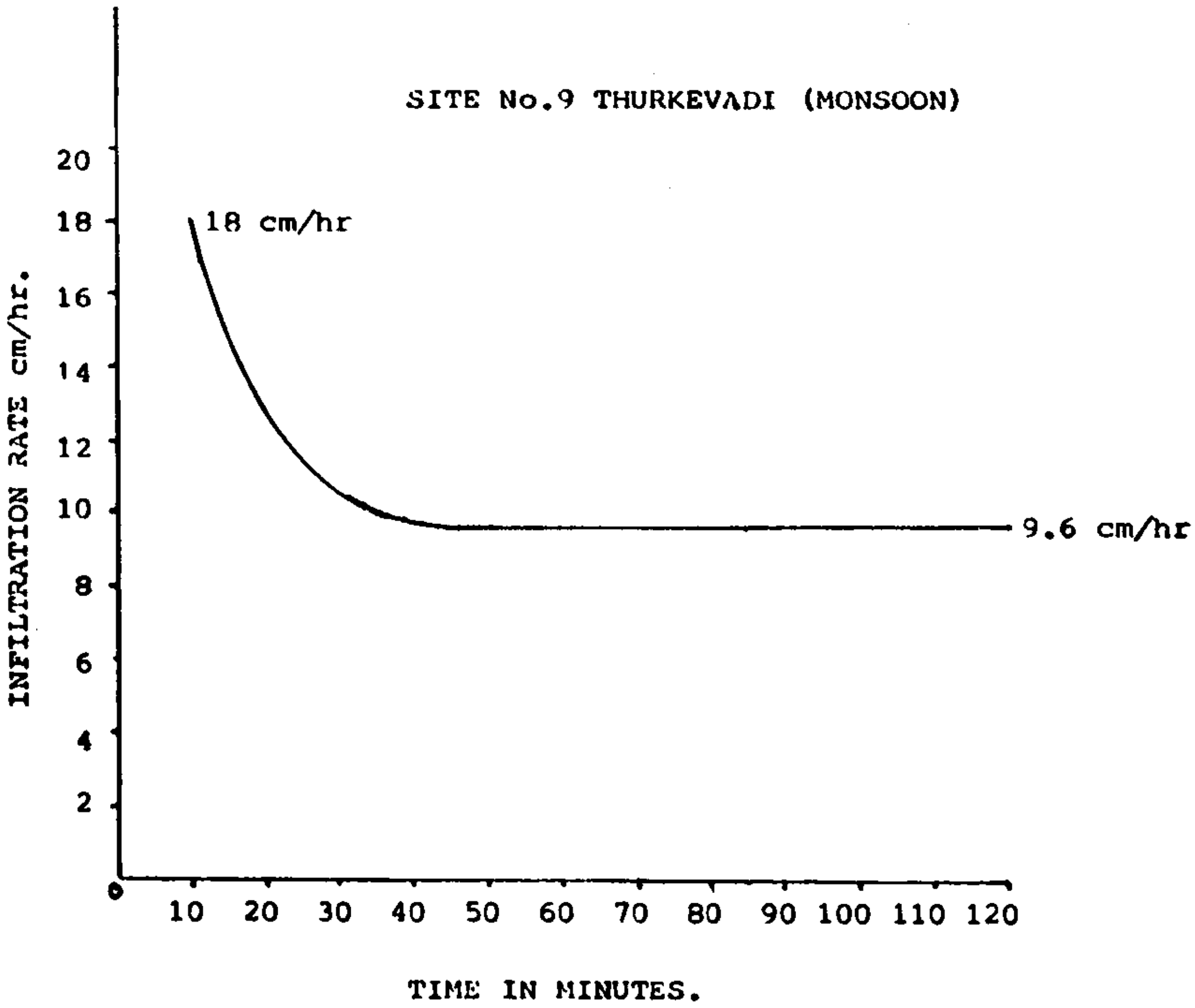
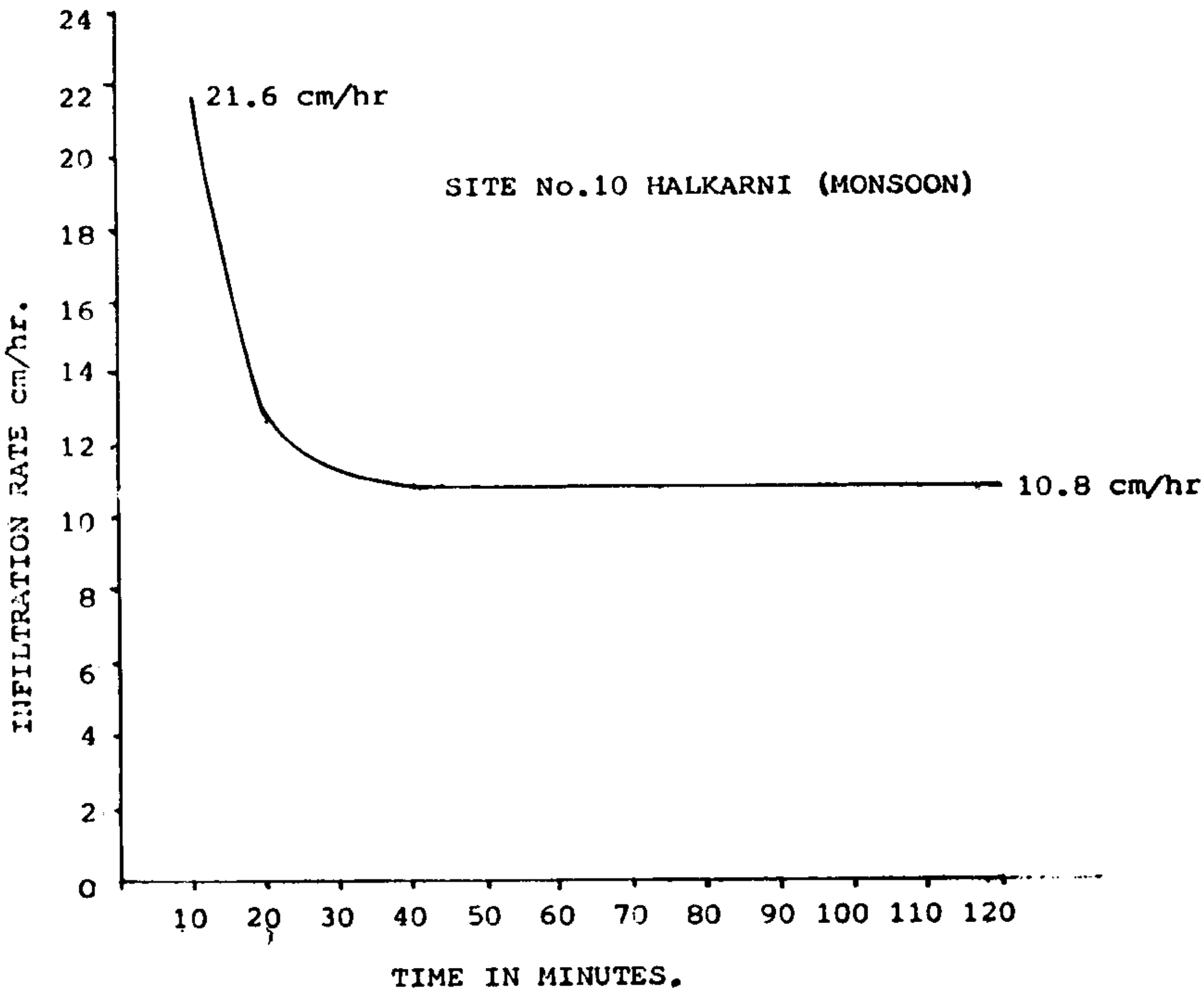



Fig:44. Infiltration curve at Thurkevadi(a)site on barren land covered by medium loam soil and underlain by basalt.




Fig;45. Infiltration curve at Halkarni site on agricultural land covered by medium loam soil and underlain by basalt

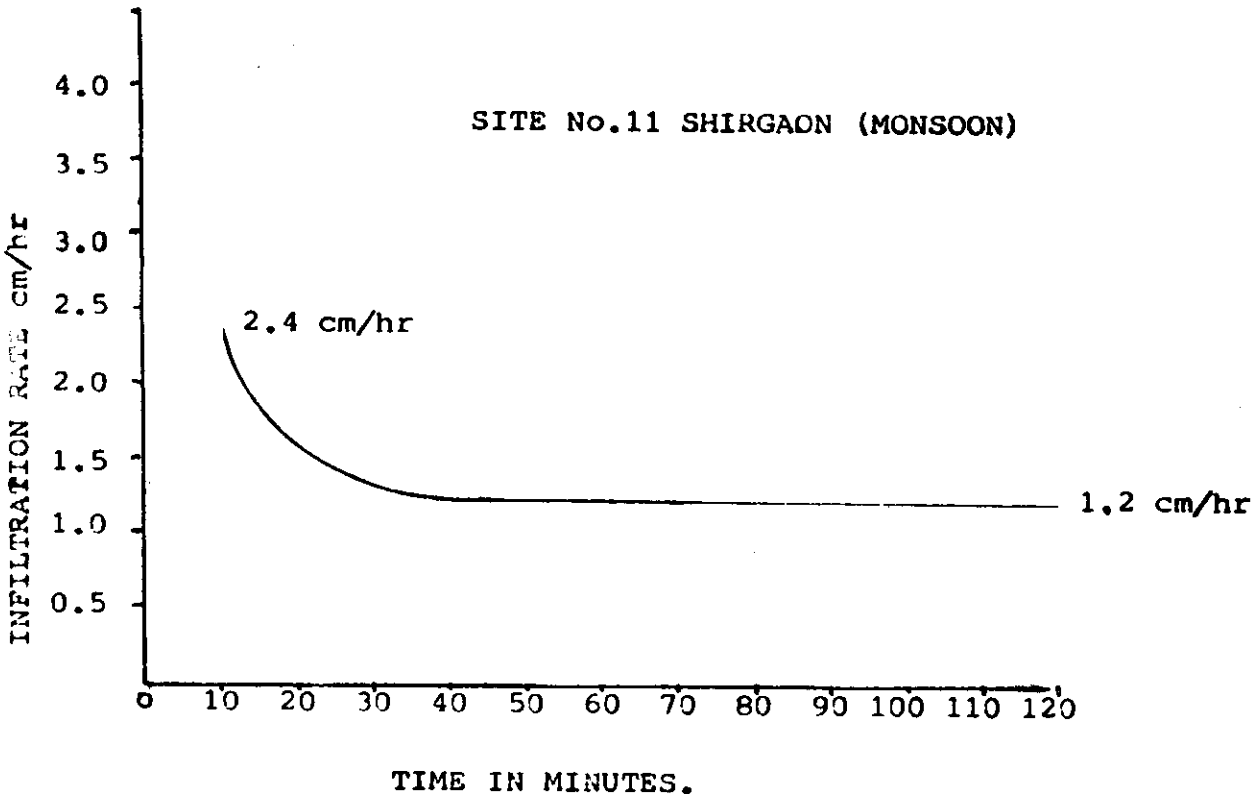



Fig.46. Infiltration curve at Shirgaon site on agricultural land covered by heavy loam soil and underlain by basalt.

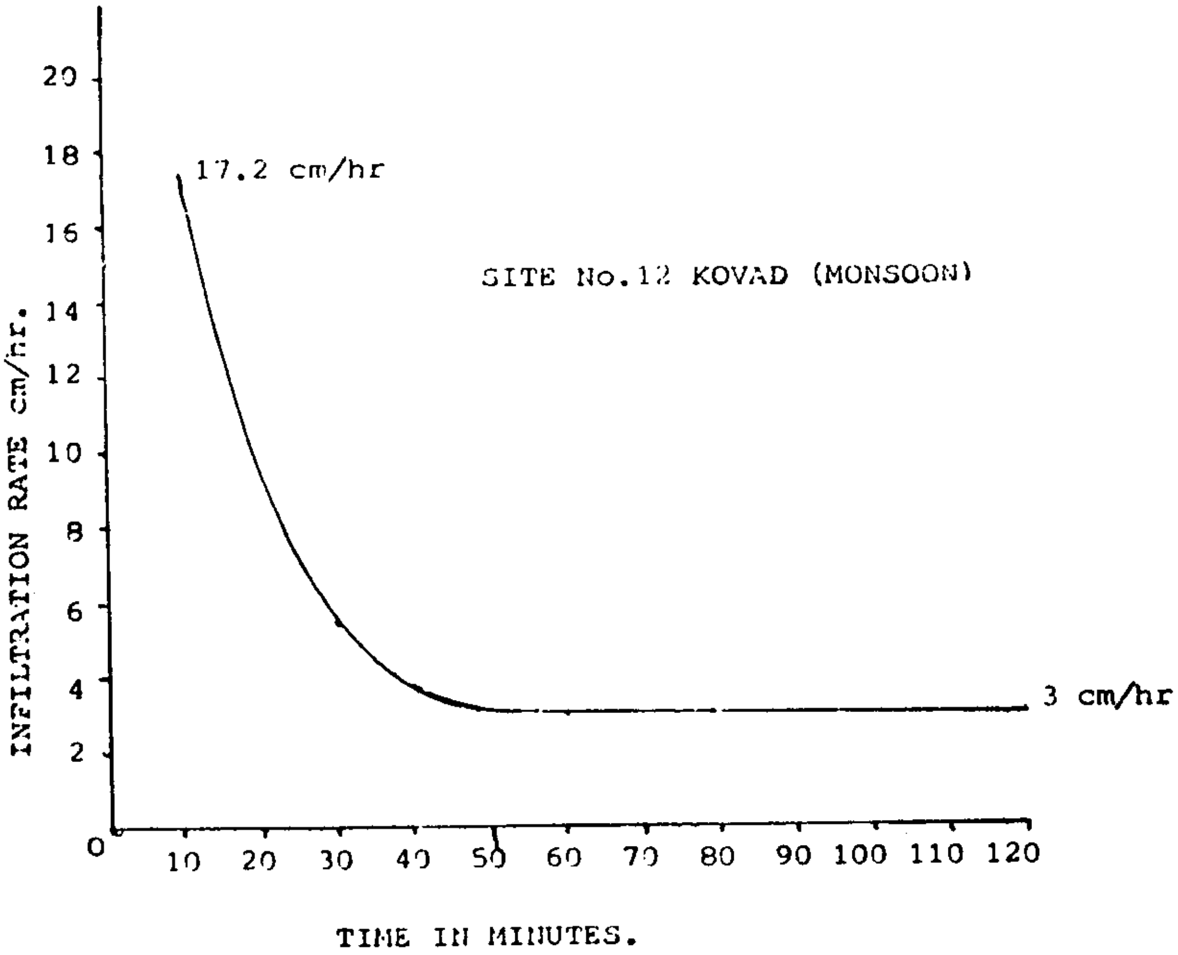



Fig:47. Infiltration curve at Kovad site on barren land covered by medium loam soil and underlain by basalt.

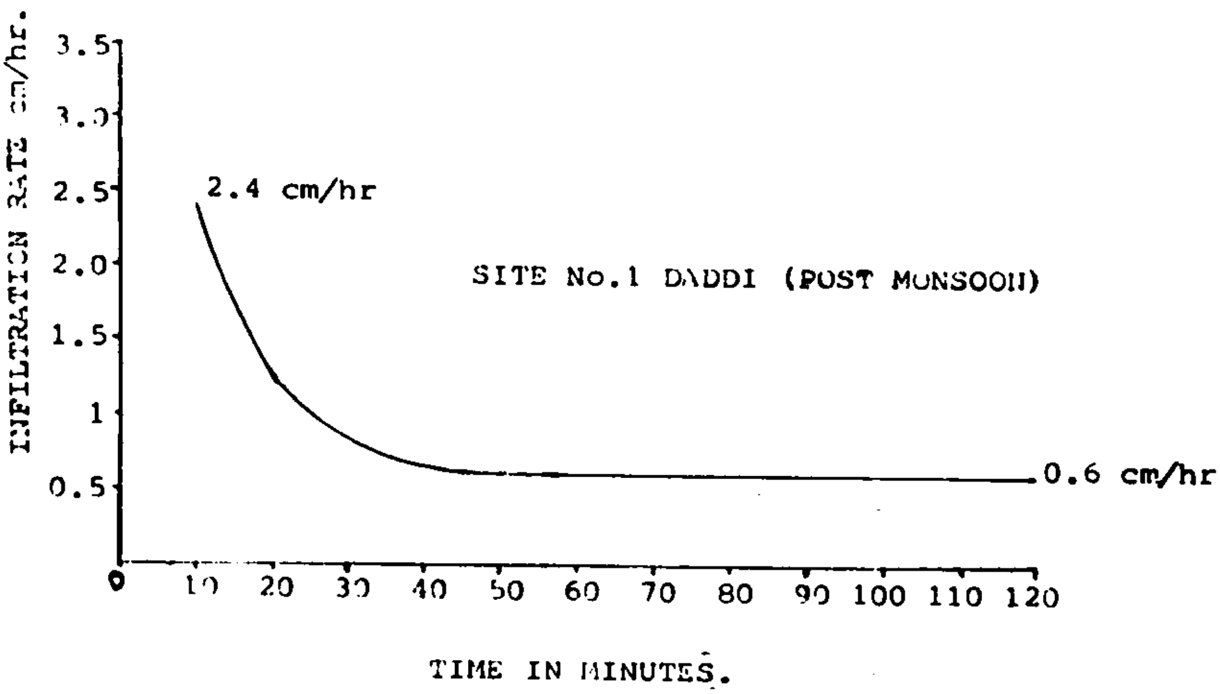



Fig:48. Infiltration curve at Daddi site on agricultural land covered by heavy loam soil and underlain by basalt.

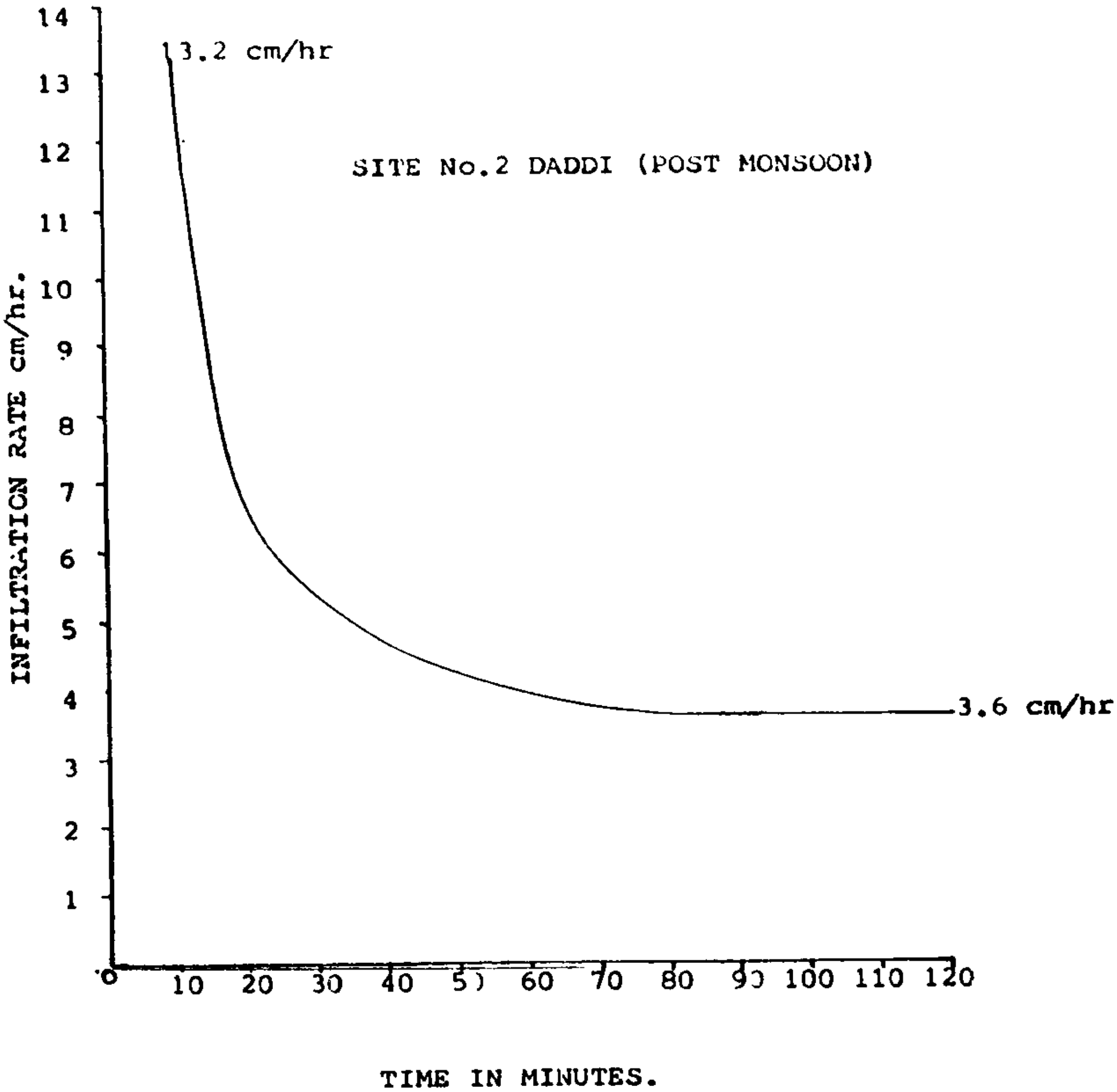



Fig: 49. Infiltration curve at Daddi (a) site on abandoned land covered by medium loam soil and underlain by basalt.

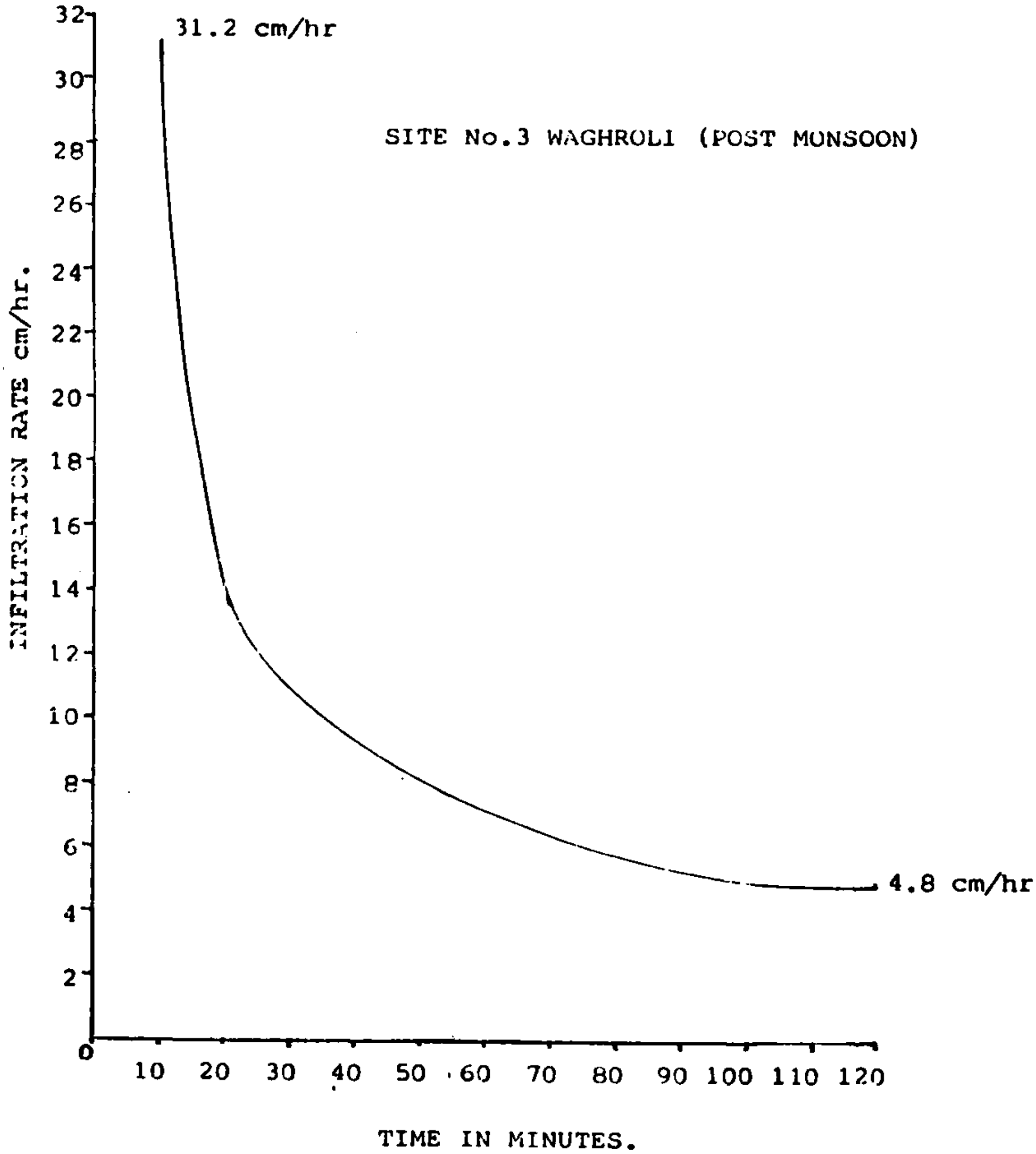
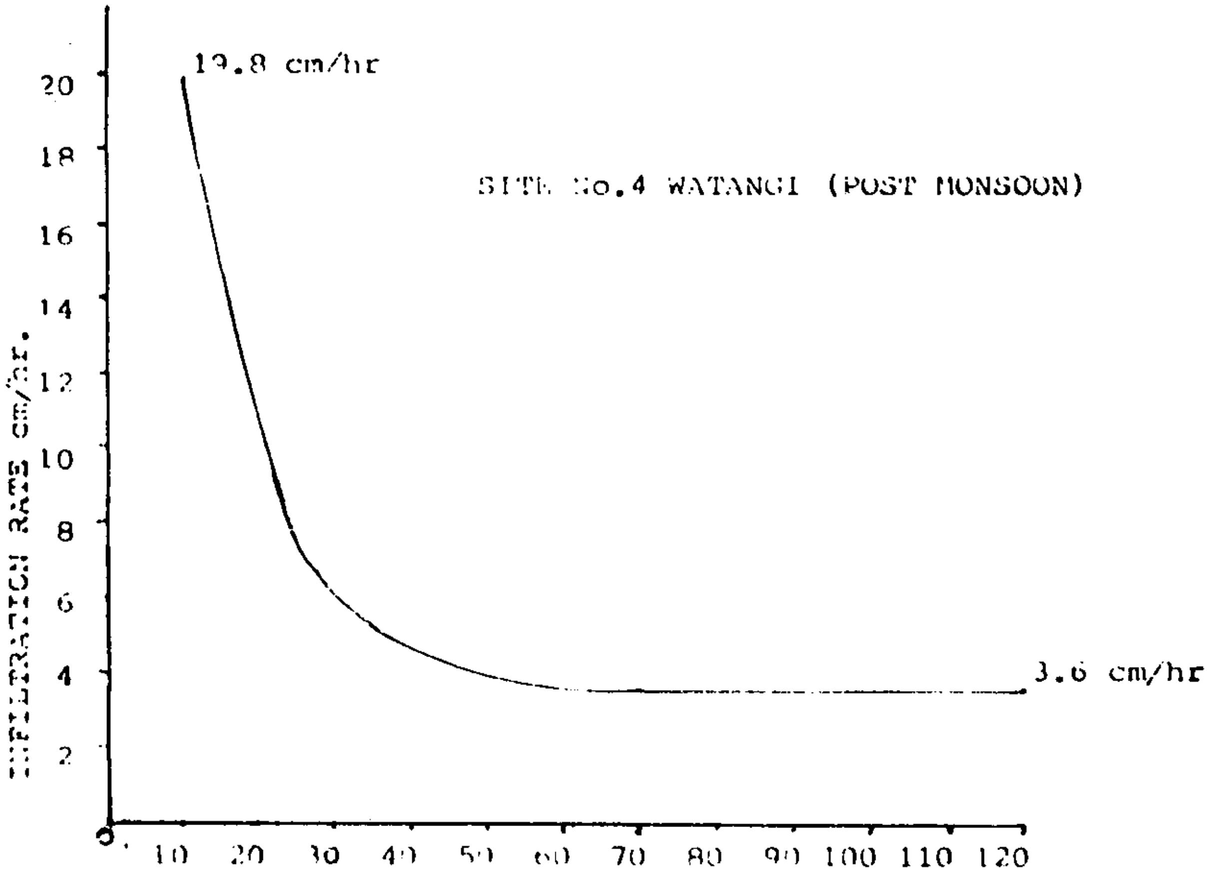



Fig: 50. Infiltration curve at Watangi site on barren land cove d by medium loam soil and underlain by basalt.




TIME IN MINUTES.

Fig: 51. Infiltration curve at Watangi site on shrubby land covered by medium loam soil and underlained by basalt.

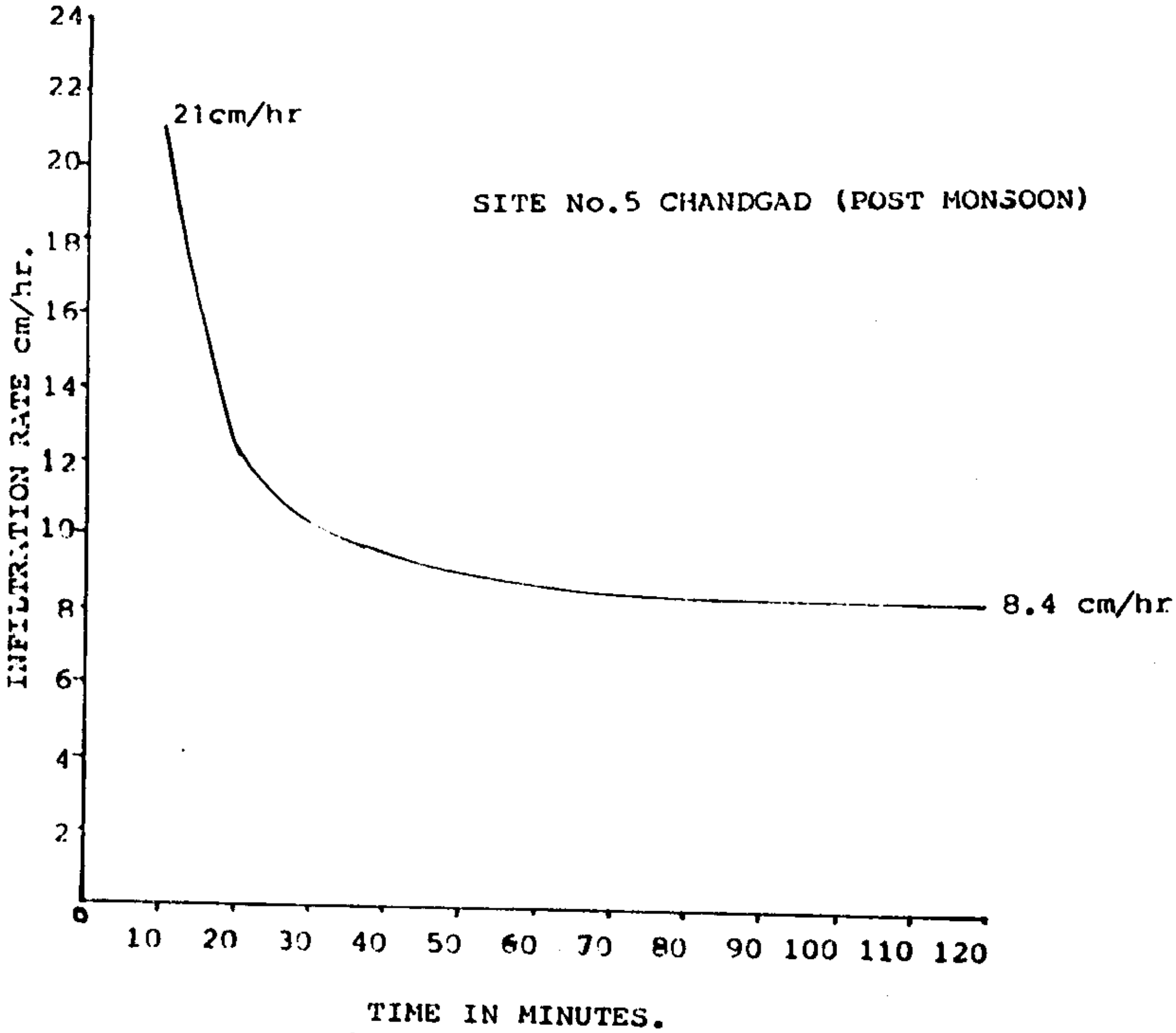



Fig: 52. Infiltration curve at Chandgad site on shrubby land covered by light loam soil and underlain by basalt.

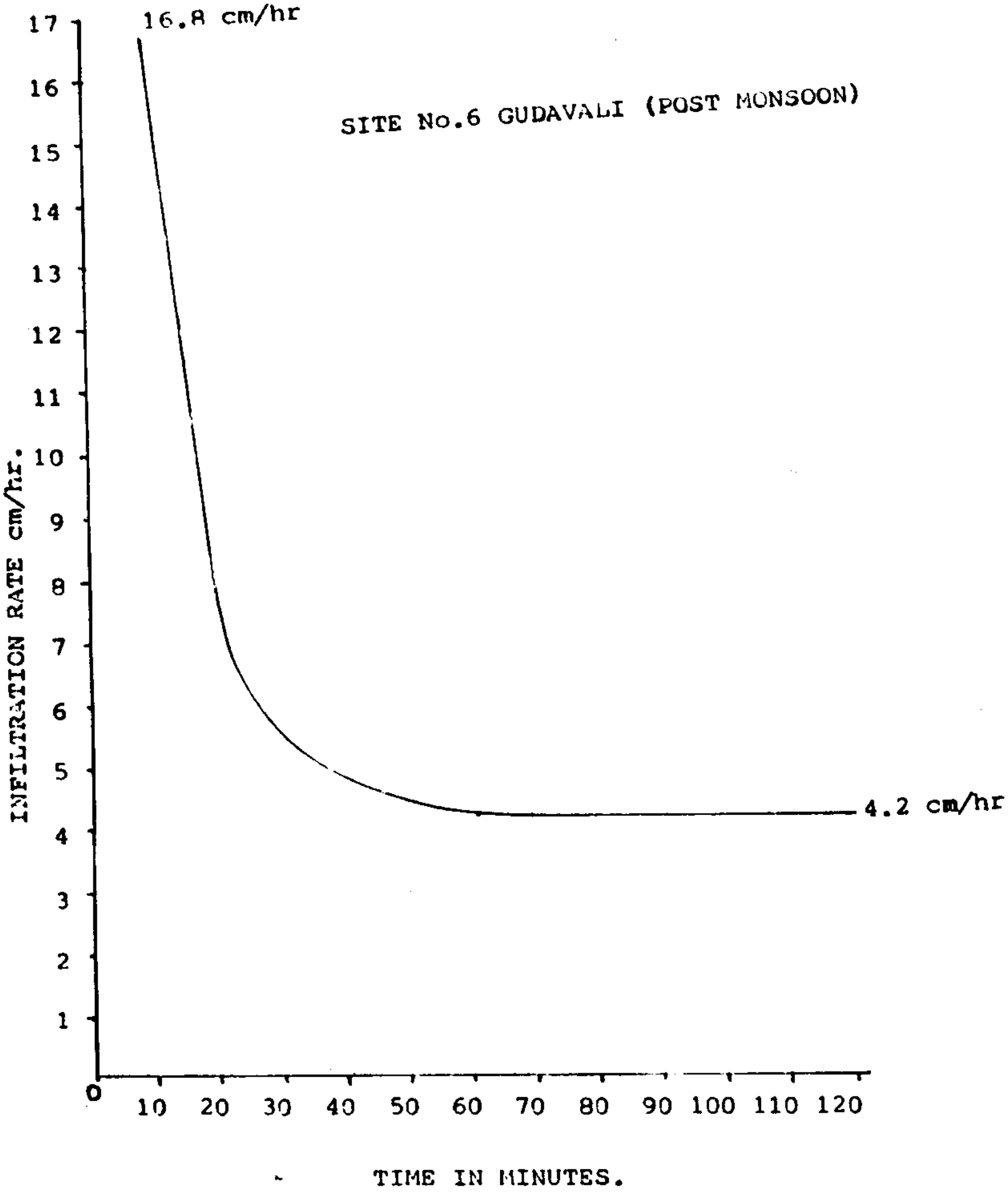



Fig: 53. Infiltration curve at Gudavali site on agricultural land covered by light loam and underlain by basalt.

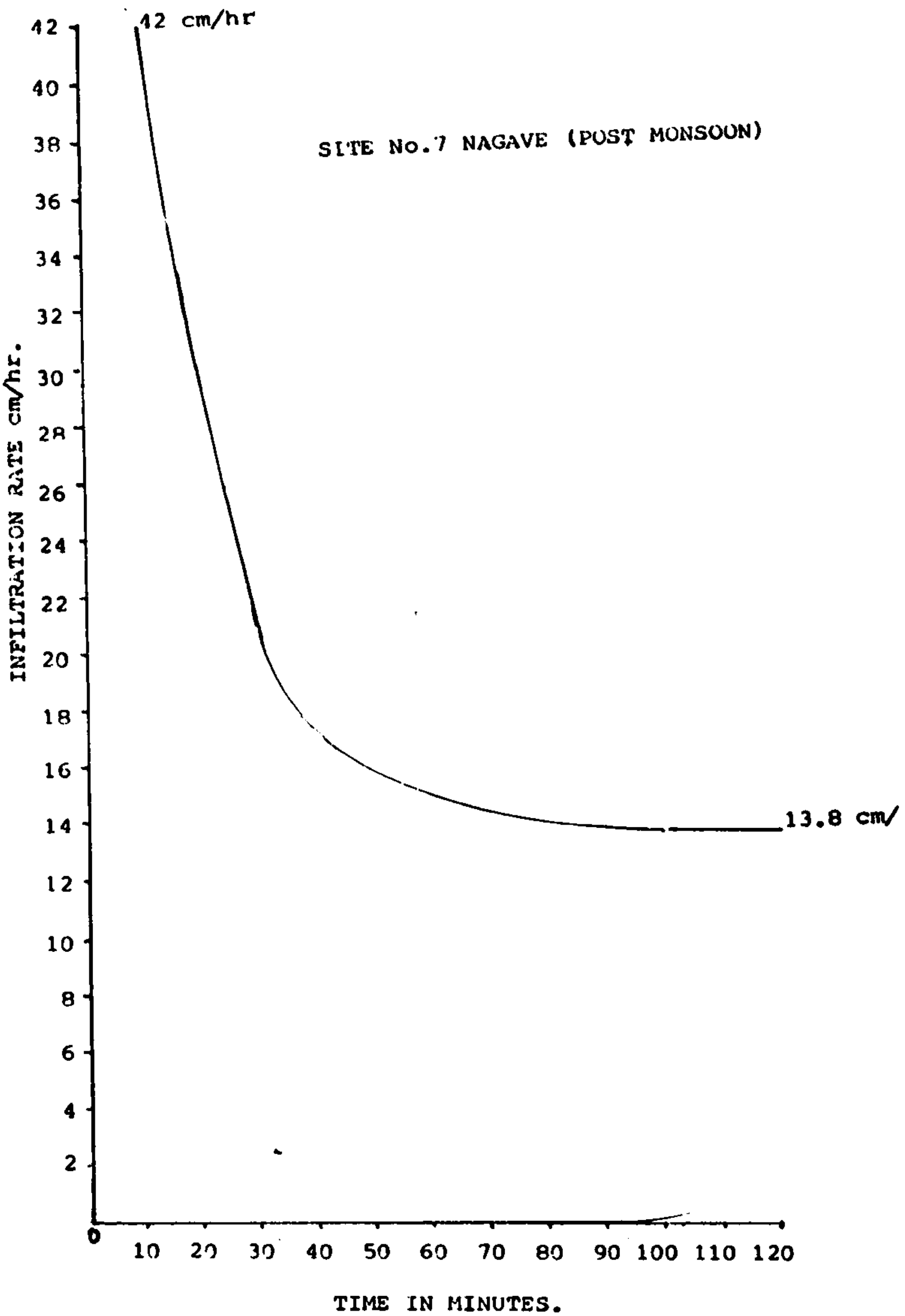



Fig: 54. Infiltration curve at Nagvey site on forest land covered by heavy loam soil and underlain by basalt.

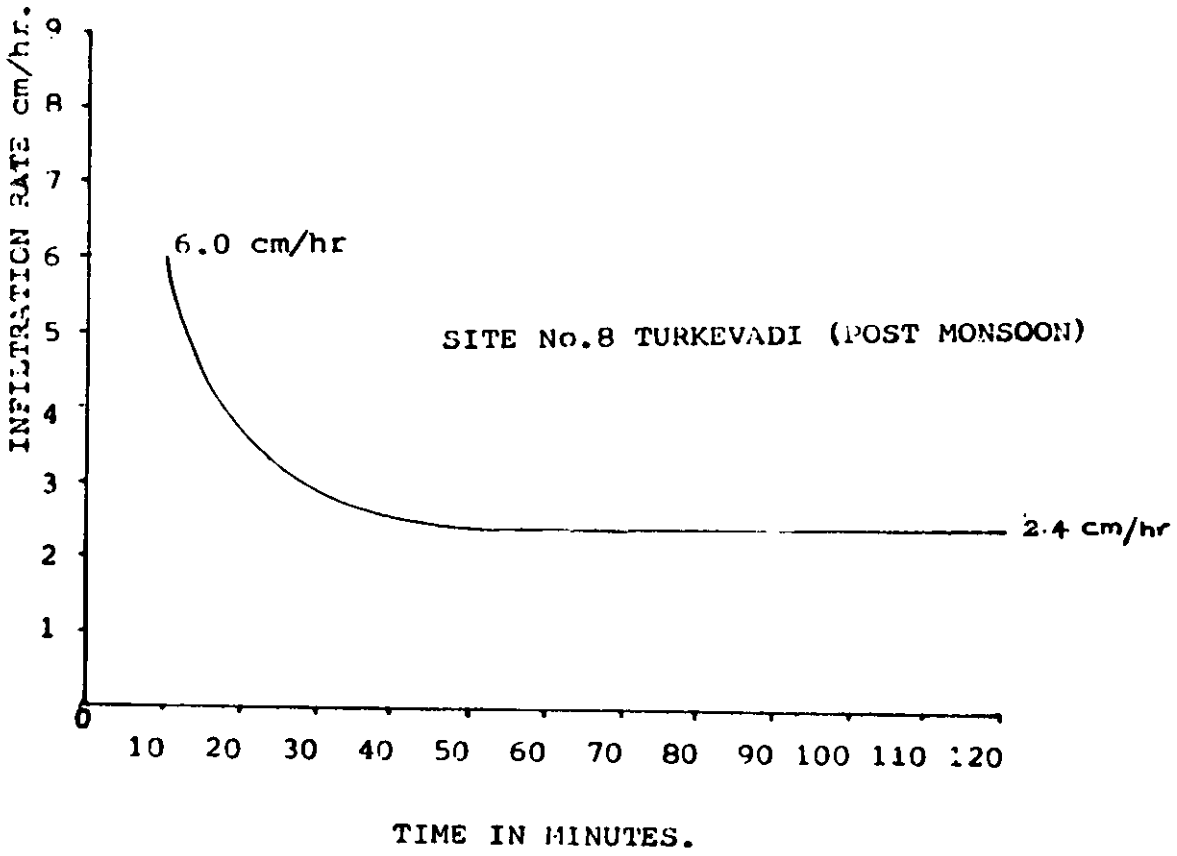



Fig: 55. Infiltration curve at Thurkevadi on agricultural land covered by medium loam soil and underlain by basalt.

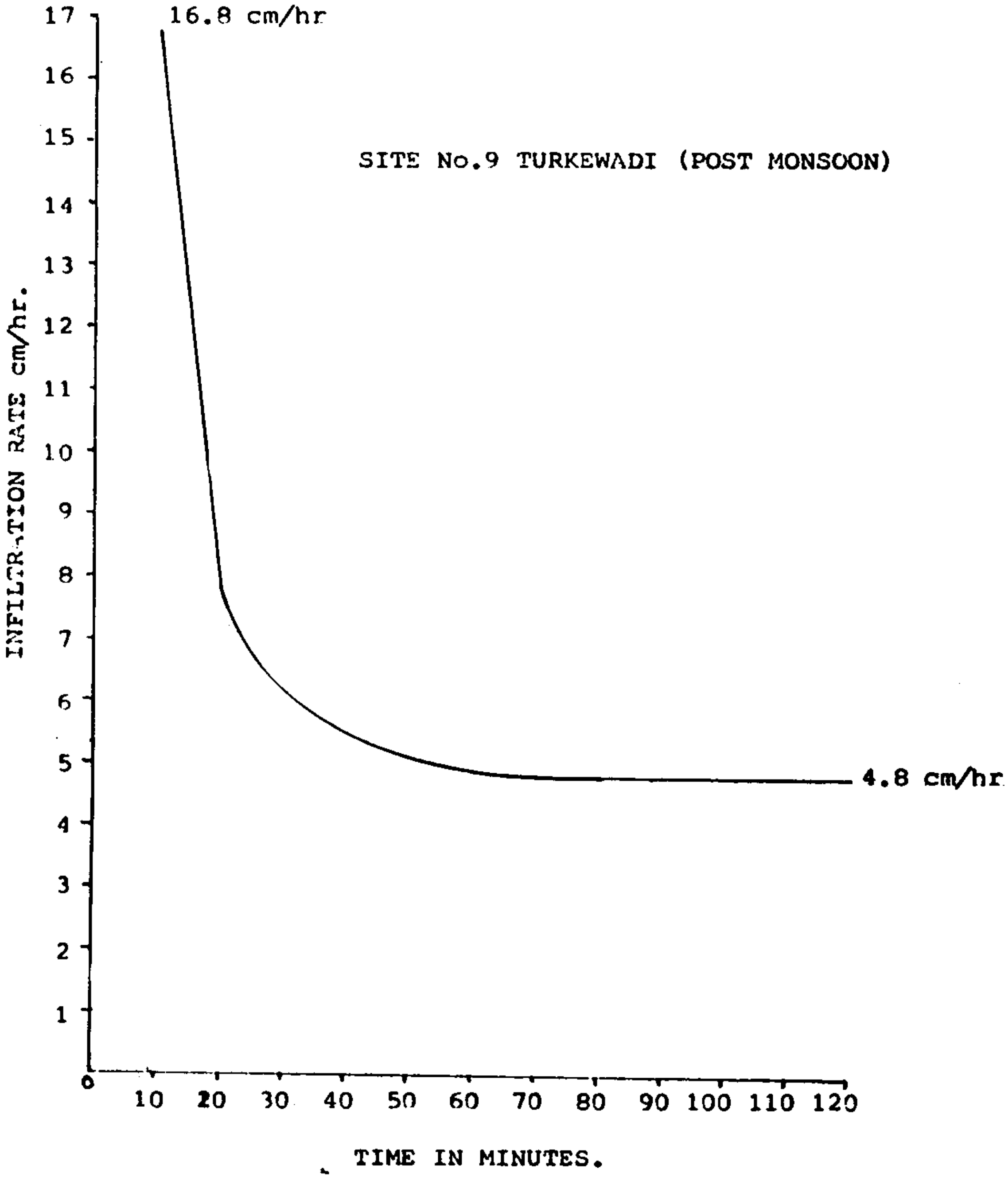



Fig: 56 Infiltration curve at Thurkevadi (a) site on barren land covered by medium loam soil and underlain by basalt.

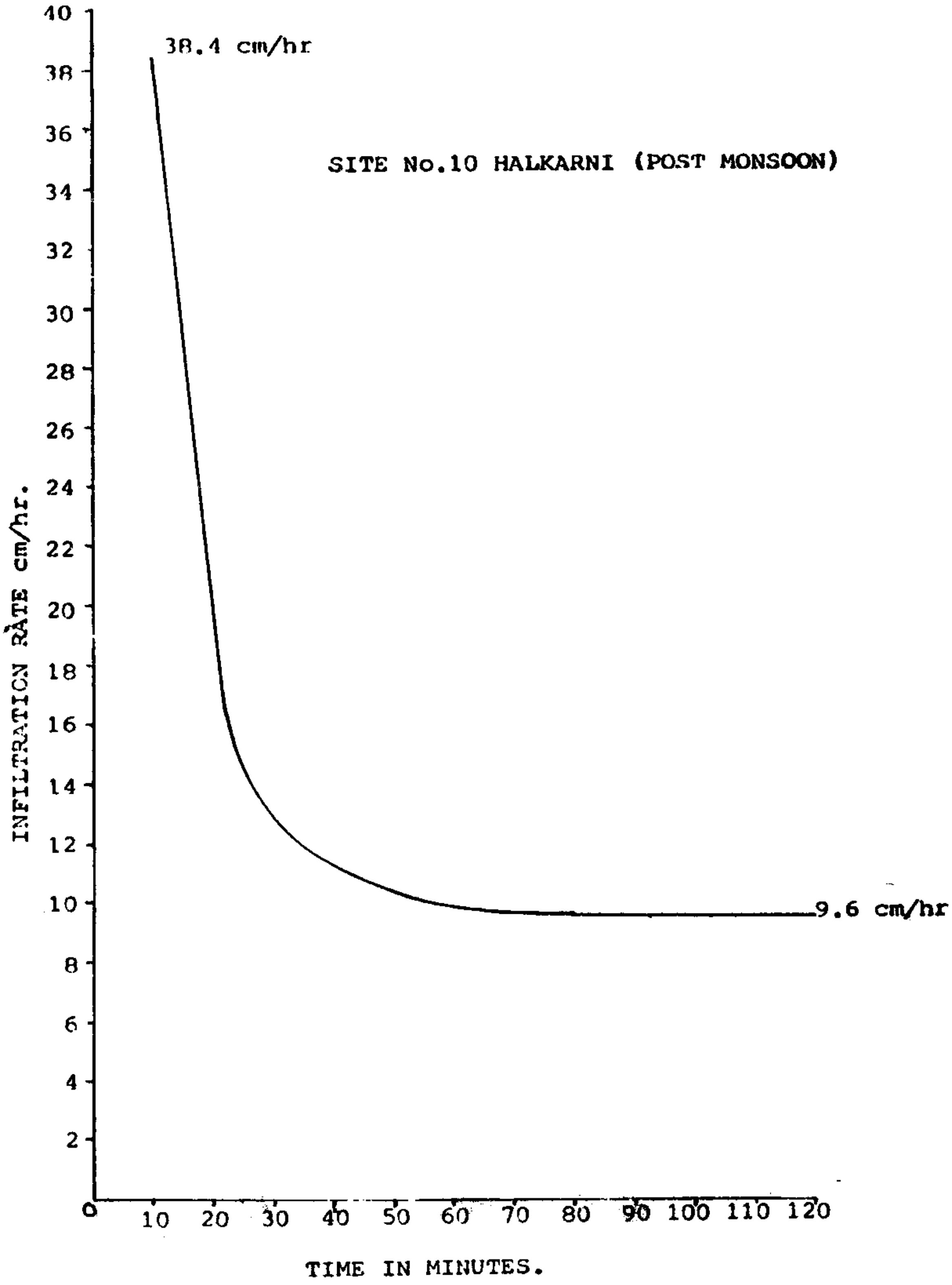



Fig: 57. Infiltration curve at Halkarni site on agricultural land covered by medium loam soil and underlain by basalt.

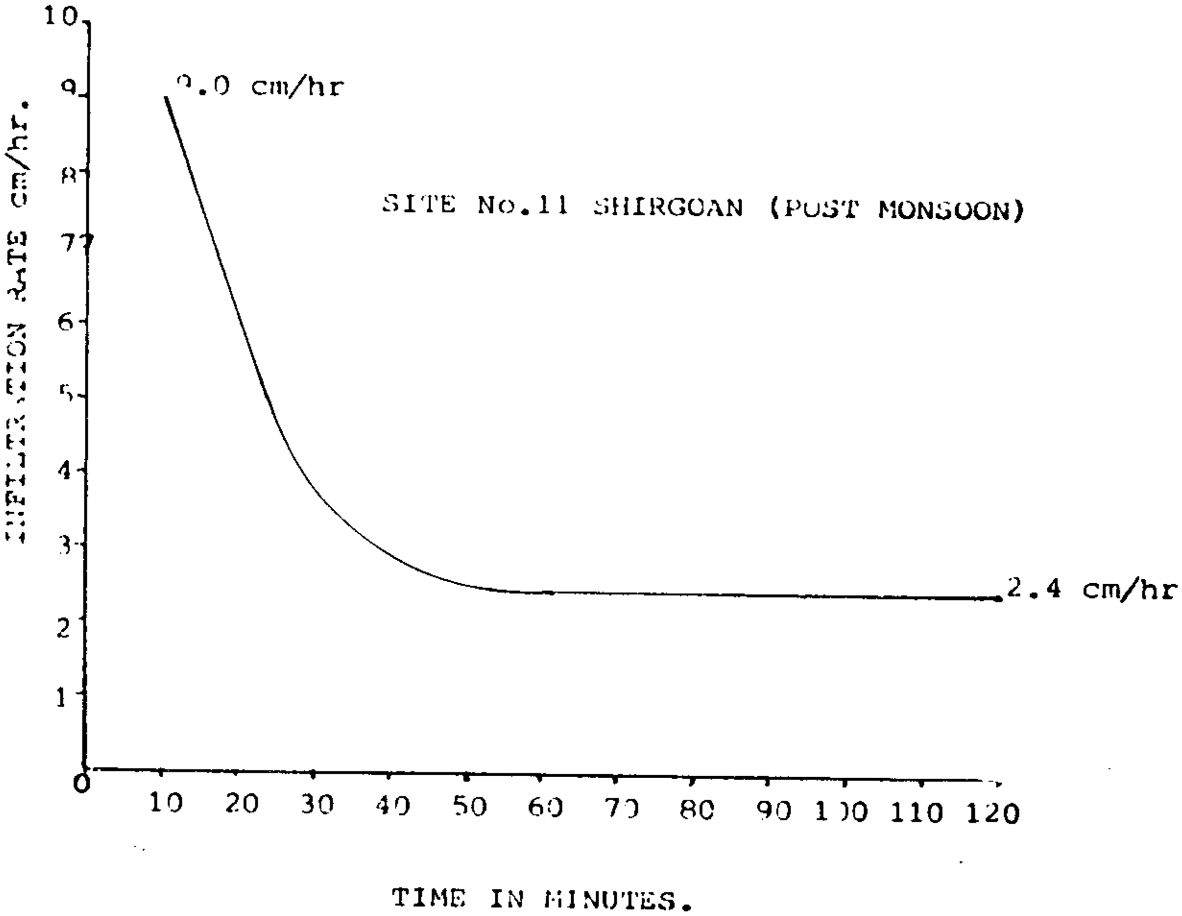



Fig: 58. Infiltration curve at Shirgaon site on agricultural land covered by heavy loam soil and underlain by basalt.

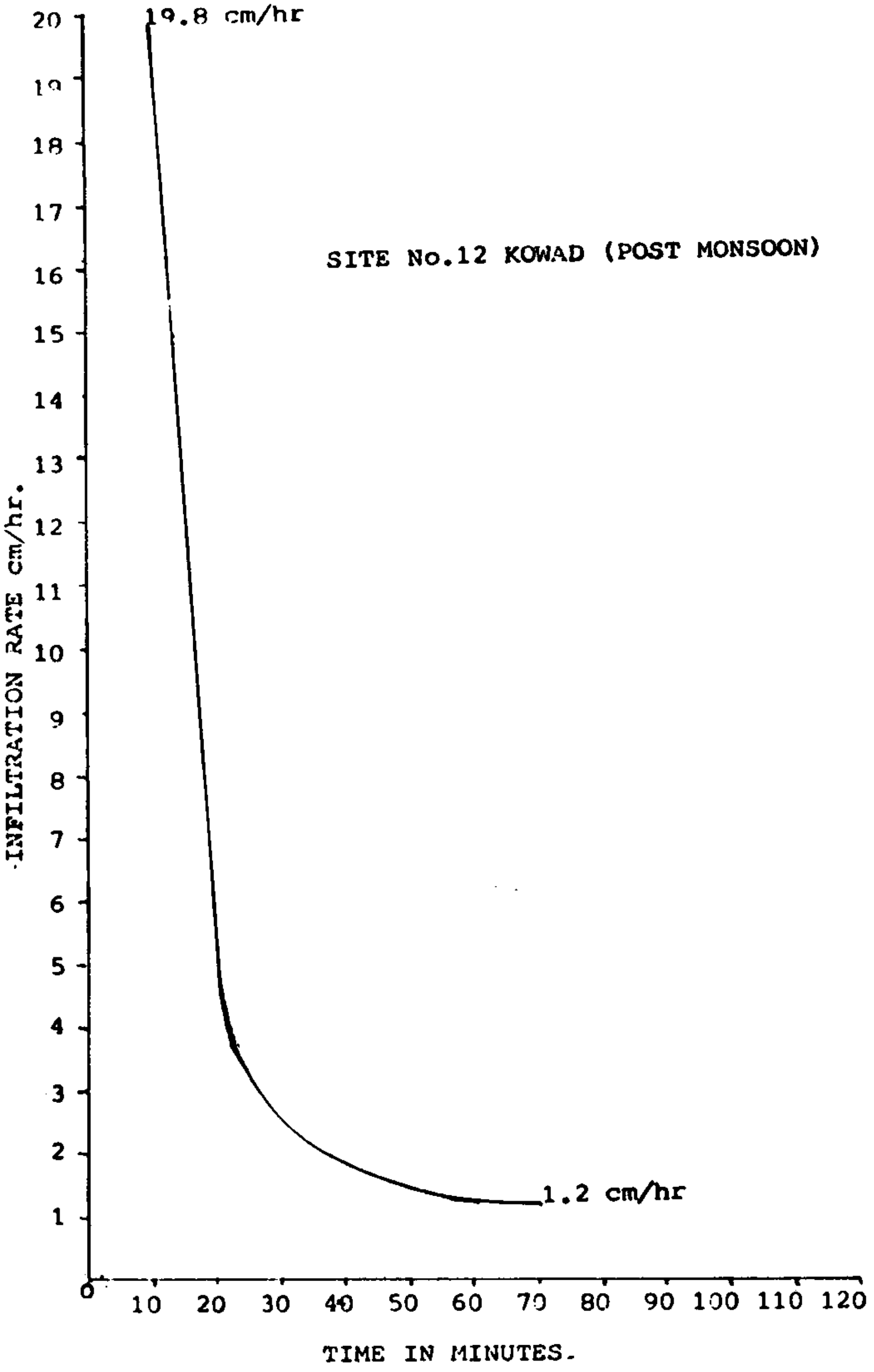



Fig: 59. Infiltration curve at Kovad site on barren land covered by medium loam soil and underlain by basalt.

# 6.0 SOIL AND INFILTRATION

## 6.1 The Malaprabha Representative Basin

The average value of infiltration rates (based on monsoon and post monsoon periods) under different soil texture of the Malaprabha representative basin are presented in the table 9. A brief account of infiltration rates in different soil types is given below.

6.1.1 Light loam : The average rate of infiltration in the light loam soil of the Malaprabha representative basin sands at 3.8 cm/hr which varies between 3.0 cm/hr under barren condition and 5.1 cm/hr under forest land.

6.1.2 Medium loam : The average rate of infiltration in the medium loam soil stands at 2.3 cm/hr which varies between 1.2 cm/hr and 3.3 cm/hr depending upon landuse pattern, other soil characteristics and topographic conditions etc.

6.1.3 Heavy loam : The average rate of infiltration in the heavy loam soil stands at 2.2 cm/hr which varies between 0.9 cm/hr and 3.6 cm/hr depending upon land use pattern topographic condition and other soil characteristics etc.

6.1.4 Clay : The average rate of infiltration in the clayey soil stands at 1.8 cm/hr which varies between 1.2 cm/hr under barren condition and 2.4 cm/hr under forest.

6.2 The Ghataprabha Representative Basin

6.2.1 Light loam :- The average rate of infiltration in the light loam soil the Ghataprabha representative basin stands at 6.6 cm/hr which varies in between 4.8 cm/hr and 8.4 cm/hr(Table 10).

6.2.2 Medium loam :- The average rate of infiltration of medium loam soil in the Ghataprabha representative basin stands at 6.3 cm/hr which varies between 2.1 cm/hr and 16.5cm/hr depending upon landuse pattern topographic conditions soil characteristics etc.

6.2.3 Heavy loam :- The average value of infiltration in the heavy loam soil in the Ghataprabha representative basin stands at 4.8 cm/hr which varies between Ø.9 cm/hr under agriculture land and 13.2 cm/hr under forest

Figure 6Ø illustrates some of the typical examples of infiltration curves under different soil texture in the Malaprabha and Ghataprabha representative basins.

Table 9: Average rate of infiltration under different types of soils having different landuse patterns in the Malaprabha representative basin.

| Infil. test site no. | soil type | Av. rate of infiltration cm/hr | Landuse | Av. rate of infiltration cm/hr |
|---|---|---|---|---|
| 4 | | | Forest | 5.1 |
| 10 | Light loam | 3.8 | Forest | 3.3 |
| 3 | | | Barren | 3.0 |
| 2 | | | Forest | 2.4 |
| 5 | Medium loam | 2.3 | Agriculture | 3.3 |
| 12 | | | Agriculture | 1.2 |
| 9 | | | Shrubs | 3.6 |
| 1 | | | Agriculture | 3.0 |
| 11 | Heavy loam | 2.2 | Agriculture | 1.5 |
| 6 | | | Agriculture | 0.9 |
| 8 | | | Forest | 2.4 |
| 7 | clay | 1.8 | [illegible] | 1.2 |

Table - 10: Average rate of infiltration under different types of soils having different landuse patterns in the Ghataprabha representative basin.

| Infil. test site no. | soil type | Av. rate of infiltration cm/hr | Landuse | Av. rate of infiltration cm/hr |
|---|---|---|---|---|
| 5 | | | Abandoned | 8.4 |
| 6 | Light loam | 6.6 | Agriculture | 4.8 |
| 13 | | | Abandoned | 2.1 |
| 12 | | | Barren | 16.5 |
| 10 | | | Agriculture | 10.2 |
| 9 | Medium loam | 6.3 | Barren | 7.2 |
| 4 | | | Shrubs | 3.6 |
| 8 | | | Agriculture | 2.4 |
| 2 | | | Abandoned | 2.1 |
| 7 | | | Forest | 13.2 |
| 3 | | | Barren | 3.3 |
| 11 | Heavy loam | 4.8 | Agriculture | 1.8 |
| 1 | | | Agriculture | 0.9 |

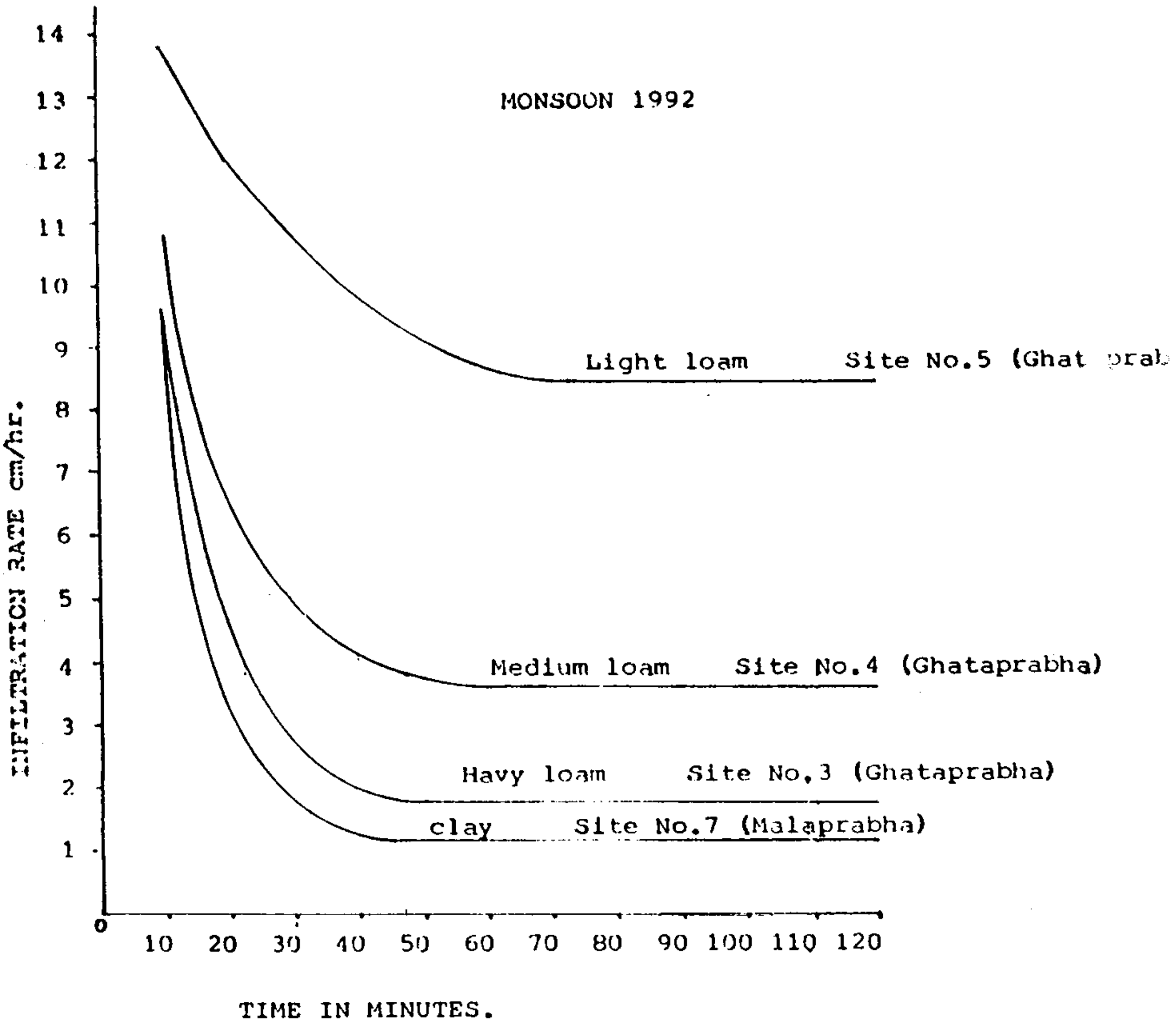



Fig. 6b Typical Example of Infiltration curves under differnt types of soils in the representative basins.

## 7.0. LANDUSE AND INFILTRATION

### .1 The Malaprabha Representative Basin

The average values of infiltration rate (based on different samples of monsoon and post monsoon periods) under different landuses in the Malaprabha representative basin are presented in table 11. A brief account of infiltration rates under different landuse patterns is given below.

7.1.1 Forest :- The average rate of infiltration in the forest of Malaprabha representative basin stands at 3.7 cm/hr which varies from place to place depending upon soil texture and other factors such as topographic condition etc.

Shrubs developed on the heavy loam soil have an infiltra tion rate of 3.6 cm/hr.

7.1.2 Agriculture land : The average rate of infiltration for agriculture land in Malaprabha representative basin stands at 2.7 cm/hr which varies between 1.3 cm/hr and 3.3 cm/hr depending upon the soil texture and topographic condition etc.

7.1.3 Barren land : The average rate of infiltration in the barren land of the Malaprabha representative basin stands at 2.2 cm/hr which varies between 1.2 cm/hr in clay soil and 3.0 cm/hr in light loam soils.

## 7.2 The Ghataprabha Representative Basin

The average values of infiltration rates (based on different samples of monsoon and post monsoon periods) under different landuses in the Ghataprabha representative basin is presented in the table 12. A brief account of infiltration rates under different landuse pattern is given below.

7.2.1 Forest :- The average rate of infiltration in the forest of the Ghataprabha representative basin, developed on heavy loam soil stands at 13.2 cm/hr.

7.2.2 Agriculture land : The average rate of infiltration in the agriculture area of the Ghataprabha representative basin stands at 3.9 cm/hr which varies between 0.9 cm/hr in heavy loam soil and 10.2 cm/hr in medium loam soils. In the abandoned agriculture land the rate of infiltration is higher than agriculture land. The average rate of infiltration in the abandoned agriculture land stands at 4.2 cm/hr which varies between 2.1 cm/hr in medium loam soil and 8.4 cm/hr in light loam soils.

7.2.3 Barren land :- The average rate of infiltration in the barren land of the Ghataprabha representative basin stands at 9 cm/hr which varies between 3.3 cm/hr in heavy loam soil and 16.5 cm/hr in medium loam soils.

Figure 61 illustrates some of the examples of infiltration curves under different landuse patterns in the Ghataprabha representative basin.

Table - 11: Average rate of infiltration under different landuse pattern having different soil texture in the Malaprabha representative basin.

| Infil. test site no. | landuse pattern | Av. rate of infiltration cm/hr | soil texture | Av. rate of infiltration cm/hr |
|---|---|---|---|---|
| 4 | | | Light loam | 5.1 |
| 8 | | | Clay | 2.4 |
| 10 | Forest | 3.7 | Light loam | 3.3 |
| 2 | | | Medium loam | 4.0 |
| 9 | Shrubs | 3.6 | Heavy loam | 3.0 |
| 1 | | | Heavy loam | 3.0 |
| 11 | | | Heavy loam | 3.0 |
| 5 | Agriculture | 2.7 | Medium loam | 1.5 |
| 6 | | | Heavy loam | 0.9 |
| 12 | | | Medium loam | 1.2 |
| 7 | | | Clay | 1.2 |
| 3 | Barren | 2.2 | Light loam | 3.0 |

Table - 12: Average rate of infiltration under different landuse pattern having different soil texture in the Ghataprabha representative basin.

| Infil. test site no. | landuse pattern | Av. rate of infiltration cm/hr | soil texture | Av. rate of infiltration cm/hr |
|---|---|---|---|---|
| 10 | | | Medium loam | 10.2 |
| 11 | | | Heavy loam | 1.8 |
| 6 | Agriculture | 3.8 | Light loam | 4.8 |
| 8 | | | Medium loam | 2.4 |
| 1 | | | Heavy loam | 0.9 |
| 13 | | | Medium loam | 2.1 |
| 5 | Abandoned | 4.2 | Light loam | 8.4 |
| 2 | | | Medium loam | 2.1 |
| 12 | | | Medium loam | 16.5 |
| 9 | Barren | 9.0 | Medium loam | 7.2 |
| 3 | | | Heavy loam | 3.3 |
| 4 | Shrubs | 3.6 | Medium loam | 3.6 |
| 7 | Forest | 13.2 | Heavy loam | 13.2 |

6

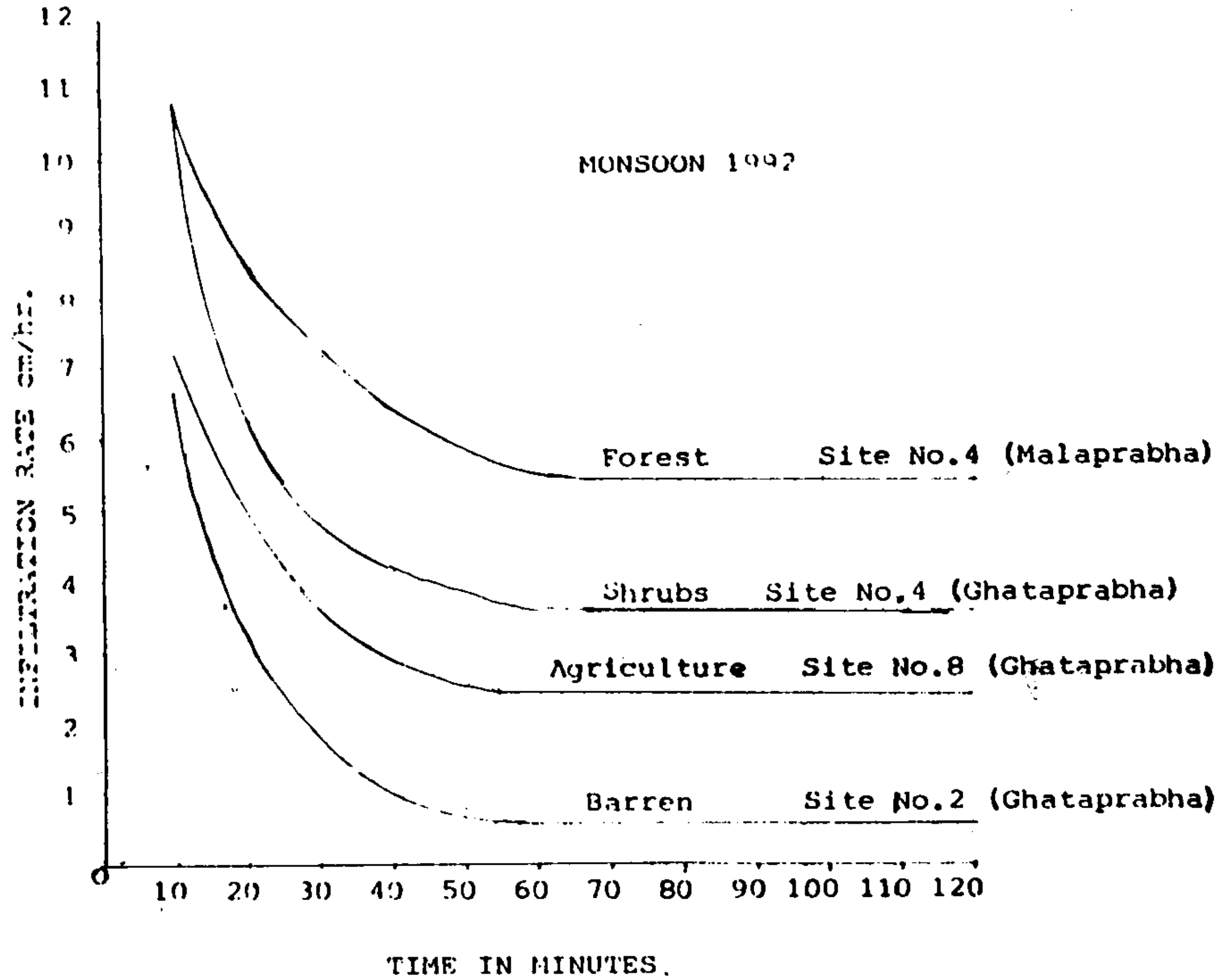



Fig.6: Typical Examples of Infiltration curves under different types of land use in the representative basins.

## 8.0 SPATIAL VARIABILITY OF INFILTRATION RATES

The rate of infiltration in different micro-hydrlogical regions varies considerably. The variation obsrved are quite pronounced in the case of Ghataprabha representative basin when compared to the Malaprabha representative basin. In general, the infiltration rate is affected by a multitude of factors (Ayers 1957; Curtis and Watson 1980; Trickler, 1981).This depends upon,

(1) Surficial Characteristics

(2) Soil Characteristics ,landuse and geology

(3) Precipitation Characteristics

(4) Antecedent Condition

The surficial characteristics may include vegetal cover conditions , topography and drainage density. These characteristics may vary widely within the watershed and have vital influence on infiltration capacity.If the soil is bare , , it is subjected to surface sealing by raindrops compaction , thus altering infiltration characteristics. A ploughed soil can result in much higher infiltration , several times more than in undisturbed soil. It is also observed during the present study that the topographic relief has an effective control over the infiltration capacity. The rate of infiltration goes upto 16 cm/hr in the slopy region.

Second most important factor controlling infiltrate capacity is soil. The soil type determines the size and number of capillaries through which water must flow. Texture , structure , biologic activity , root penetration and colloidal swelling are the important soil characteristics.These determine the nature and magnitude of the porosity of the soil. The number of pore spaces depend upon the soil type. The infiltration rate varies with soils containig silts and clays. Silts have very less permeabili ty whereas clays are impermeable. The varying proportions of silt or clay may change the infiltration rate considerably. Landuse and soil temperature are the other factors governing the infil tration rate. This fact is well established from the study. We have conducted experiments on agriculture land having different types of agriculture (ex. sugarcane, paddy, ragi etc;)This gave different values of infiltration rate. Further more , the experi ments were conducted where there was no agriculture. This also indicated different rate of infiltration. The soil type in turn is dependent upon geology. Considering the the geology of the area , the experiments were conducted . This gave us an idea that geology also have a major role in controlling the infiltration rate.

Third factor , which should be considered is precipita tion characteristics space time distribution of rainfall intensity and duration , dropsize , angle of incidence and the form of the precipitation characteristics.

Antecedent soil moisture conditions are extremely important to infiltration. The moisture content determine the capillary potential in the soil and the capillary conductivity. Indeed it is the moisture content that principally decides the runoff and its time of occurrence due to given rainfall episode. Therefore , soil moisture content also bears responsibility for the variation of infiltration rate.

Considering most of the above said factors , the Malaprabha representative basins may be divided into nine micro hydrological regions. The rate of infiltration were observed both during monsoon and post monsoon periods. Based on the results (table 13), the entire Malaprabha representative basin can be demarcated into three zones having different infiltration rates (Fig.62).

(1) Zone no I : This region is having infiltration rate 3-4 cm/hr which is mainly covered by forests and Red loamy soils underlain by basalts. The higher rate of infiltration in this zone may be mainly due two reasons ,(1) Due to extensive forests, the runoff will be less thereby giving rise to higher rate of infiltration, (2) Red loamy soils are comparatively better permeable than medium black soils.

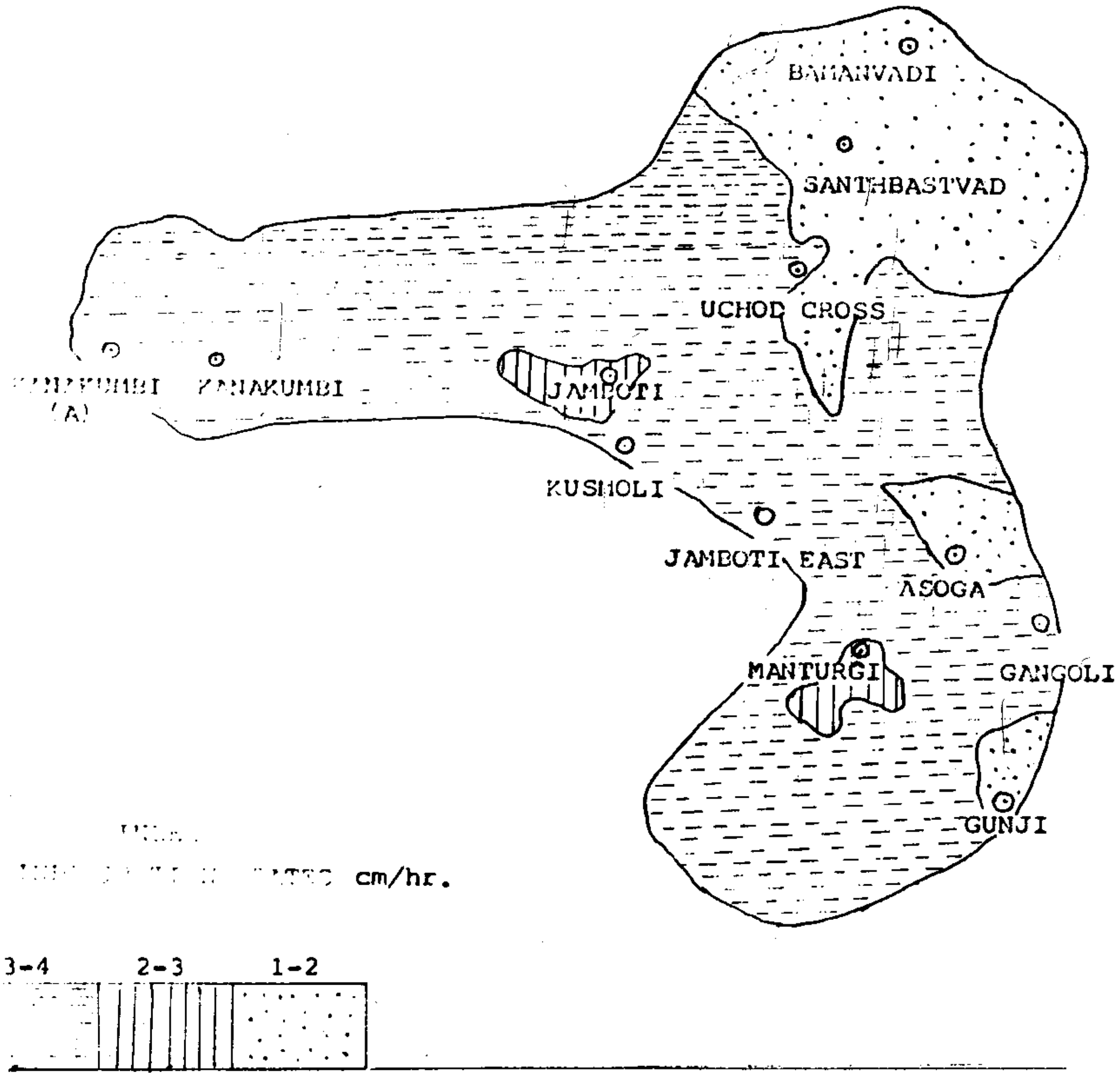



Fig.62: Spatial verability in the infiltration rate in the Malaprabha representative basin.

Table 13: The spatial variation of infiltration rate Malaprabha representative basin.

| No. | Micro region | rate of infiltration cm/hr |
|---|---|---|
| 1. | Agriculture land with medium black soil and basalt rocks | 1 - 2 |
| 2. | Shrubby area with medium black soil and basalt rocks | 3 - 4 |
| 3. | Barren land with medium black soil and basalt rocks | 1 - 2 |
| 4. | Forest area with red loamy soil and basalt rocks | 3 - 4 |
| 5. | Agriculture land with red loamy soil and basalt rocks | 2 - 3 |
| 6. | Forest area with medium black soil and basalt rocks | 3 - 4 |
| 7. | Forest area with red loamy soil and sedimentary rocks | 3 - 4 |
| 8. | Agriculture land with red loamy soil and sedimentary rocks | 1 - 2 |
| 9. | Barren land with red loamy soil and basalt rocks | 3 - 4 |

(2) Zone no II : This is having the rate of infiltration between 2-3 cm/hr. These areas are covered by agriculture found within the forest area. The decrease of infiltration when compared to the previous one, could be due to the type of agriculture (cropping pattern) held at the time of conducting the experiment.

(3) Zone no III ; Rate of infiltration is between 1-2 cm/hr. Here , the rate is very less mainly due to the soil type and some pockets of the land are barren in nature.

In the Ghataprabha representative basin a wide variation in the rate of infiltration are observed. . The values vary between 1-14 cm/hr . The maximum is observed in the forest region and the minimum is in the agricultural land. Based on the infiltration rate (Table 14), it is classified into 8 zones (Fgi.63).

(1) Zone no. I : The rate of infiltration is between 13-14 cm/hr. This region is completely covered by dense forests with lateritic soils. Apart of this region is underlain by sedimentary formation but no much variation in the rate of infiltration is observed.

(2) Zone no II : Infiltration rate is between 8-9 cm/hr. This zone is covered by shrubs having lateric coarse shallow soil. Here, the vegetative cover is comparatively less than the previ

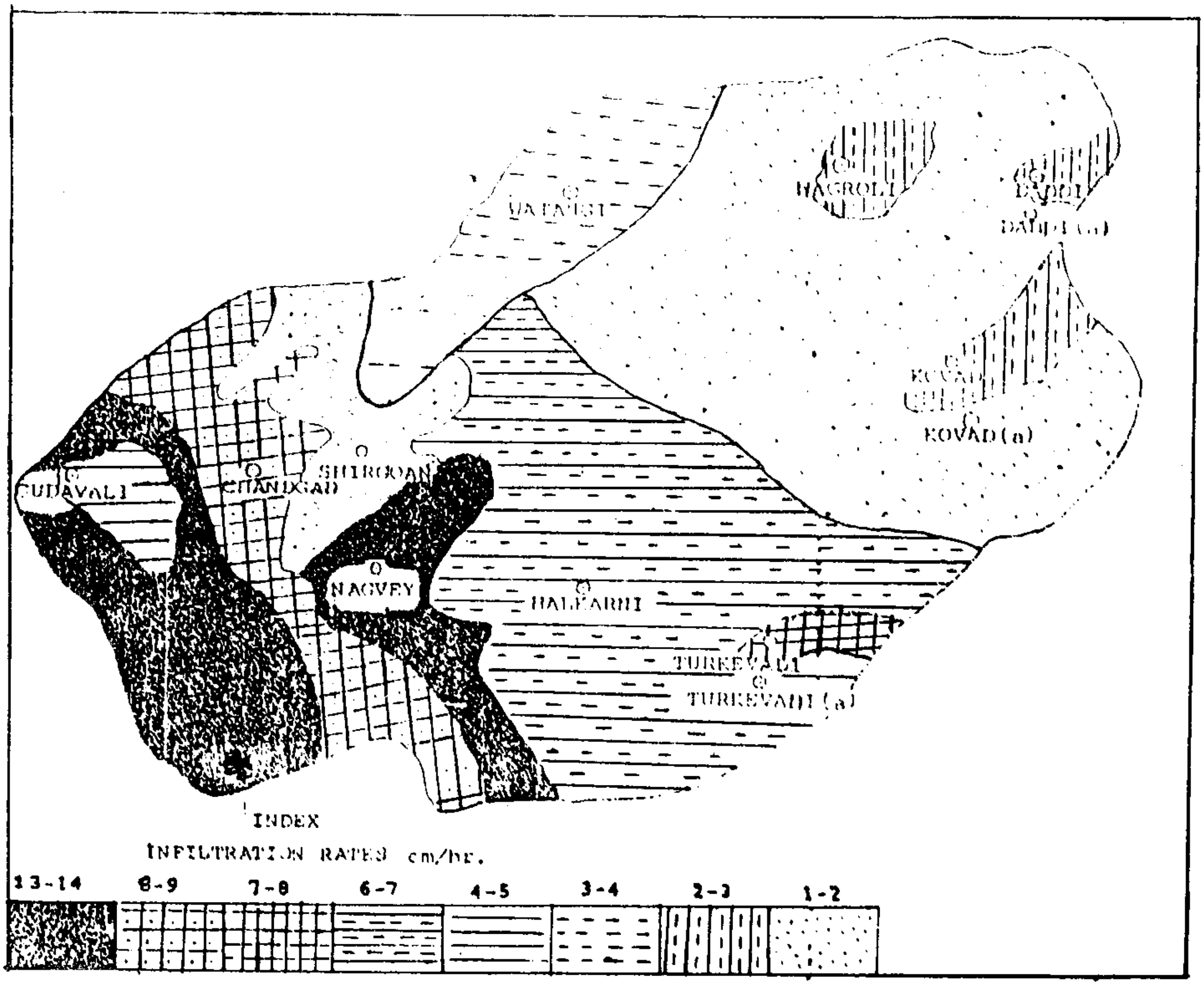



Fig.63: Spatial variability in the infiltration rate in the Ghataprabha representative basin.

ous one. This may be the reason for the reduction in infiltration rate.

(3) Zone no III : Range of infiltration varies between 7 8 cm/hr. This is a small patch of barren land with medium deep soil. The rate of infiltration observed at this point shows that this part of the land may be converted agriculture provided, if it is economical

(4) Zone no IV :Infiltration rate isd between 6 7 cm/hr. This region is covered by agriculture having coarse shallow soil underlain by sedimentary rocks.In this part of the land the infiltration values mainly depends upon the type of cropping pattern.

(5) Zone no V : This part of land has an infiltration rate between 4-5 cm/hr. Though the area is lying as a small patch within the sorrounded by dense forest area the rate of infiltra tion comparatively very less. The type of agriculture which may be absorbing higher water content during the process of infiltra tion.

(6) Zone no VI : Rate of infiltration in this region varies betwen 3-4 cm/hr. This part is covered by shrubs with coarse shallow soil and basaltic rocks. Though a high infiltration rate is expected , it seems to be very less which due to the topo

graphic variation. This is some what slopy land with intermettent clays.

(7) Zone no VII : Infiltration rate ranges between 2-3 cm/hr Reduction in the rate of infiltration is due to the fact that most of the land covered in this zone are barren land.

(8) Zone no. VIII : Infiltration rate observed here varies between 1-2 cm/hr. This is the minimum rate of infiltration in the catchment. Though the region is an agriculture land rate of infiltration is very less. The soil type iis coarse black shallow soil underlain by basalts . These coarse shallow black soils are generally less permeable thereby reduces the rate of infiltration to a minimum.

Table - 14:- Spatail variation of infiltration rate of the micro hydrological regions in the Ghataprabha representative basin.

| No. | Micro region | rate of infiltration cm/hr |
|---|---|---|
| 1. | Forest land with coarse shallow soil and sedimentary rocks | 13 - 14 |
| 2. | Agriculture land with coarse shallow soil and sedimentary rocks | 4 - 5 |
| 3. | Shrubby area with medium deep soil and basalt rocks | 8 - 9 |
| 4. | Agriculture land with medium deep soil and basalt rocks | 1 - 2 |
| 5. | Forest area with medium deep soil and basalt rocks | 13 - 14 |
| 6. | Shrubby area with coarse shallow soil and basalt rocks | 3 - 4 |
| 7. | Agriculture land with coarse shallow soil and basalt rocks | 1 - 2 |
| 8. | Barren land with coarse shallow black soil and basalt rocks | 2 - 3 |
| 9. | Barren land with medium deep soil and basalt rocks | 7 - 8 |
| 10. | Agriculture land with medium deep soil and basalt rocks | 6 - 7 |

CONCLUSION

A number of experiments have been conducted in the Malaprabha and Ghataprabha representative basins to understand the infiltration characteristics of the basins. It is found that the average infiltration rate in the Malaprabha representative basin stands at 2.7 cm/hr which varies between 0.9 cm/hr and 5.1 cm/hr.

In the Ghataprabha representative basin the average rate of infiltration is 5.9 cm/hr which varies between 0.9 cm/hr and 16.5 cm/hr.

* The infiltration rate under different soils and lan-duse pattern varies widely . This is evident from the present study. The average rate of infiltration rate in the light loam soil of the Malaprabha representative basin is 3.8 cm/hr . In the case of Ghataprabha representative basin variation is between 4.8 cm/hr and 8.4 cm/hr . Under medium loam condition the rate of infiltration stands at 2.3 cm/hr in Malaprabha and 6.3 cm/hr in Ghataprabha representative basins. If soil texture is heavy loam the rate of infiltration is 1.8 cm/hr in the Malaprabha and 4.8 cm/hr in the Ghataprabha representative basins.

* The rate of infiltration observed under different landuse pattern varies significantly. A forest land in Mala-

prabha representative basin has an infiltration rate of 3. cm/hr, whereas in the case of, Ghataprabha representative basin it goes upto 13.2 cm/hr. The infiltration rate on the agriculture land stands at 2.7 cm/hr and 3.9 cm/hr for Malaprabha and Ghataprabha representative basin respectively. On barren lands the rate of infiltration observed in Malaprabha representative basin is 2.? cm/hr and in Ghataprabha representative basin it is 9 cm/hr.

* From the above results it is understand that the rate of infiltration varies considerably under different environmental and field conditions. Therefore, based on present data the Malaprabha representative basin can be divided into 9 and Ghataprabha representative basin into 10 micro-hydrological regions, considering geology, landuse and soils which are the prime factors for controlling the infiltration rate.

* One of the most dominant feature noted is that, in the Ghataprabha representative basins, the rate of infiltration (average 5.9 cm/hr), is more than double when compared to the rate of infiltration in Malaprabha representative basin ( average 2.7 cm/hr). The reason for this anomaly could be due to the following reasons.

(1) Topographic variation, i.e., the Ghataprabha representative basin is more flatter and gentler than Malaprabha representative basin

(2) The water yield in the Ghataprabha representative basin is quite higher than in the case of Malaprabha representative basin which is an indication of higher infiltration capacity and flatter topography.The average water generating capacity of the Ghataprabha representative basin from land to channels is 2.96 cumecs/sq.km/day and it is 1.38 cumecs /sq.km/day in the Malaprabha representative basin.

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APPENDIX- J

# FIELD GUIDE NOTE BOOK FOR INFILTRATION TESTS

This field guide note book is intended to introduce some of the techniques to define the environment and soil characters around the infilbration test site and method of infiltration test . One should note two sets of parameters thoroughly as much as possible . These are :

* environment around the infiliration test site , a
* infiltration test site parameters

The contents covered in this note will provide necessary guidance to record environment around the test site and carry out the field test However , it would be better , if i could be supplimented with details and analysis of your interest and knewledge.

# ENVIRONMENT AROUND THE SITE

## 1.0 SITE AND SITUATION/LOCATION

1.1 Name of the site ____________________

1.2 Taluk/District/State ____________________

1.3 Map Reference ____________________

1.4 Map Symbol ____________________

1.5 Latitude/Longitude ____________________

## 2.0 LOCAL RELIEF

2.1 Topo site Crest/Spur/Valley/Terrace

2.2 Altitude ____________________

2.3 Slope Form Convex/Cancave/planar/Flat

2.4 Slope Angle ____________________

2.5 Orientation of slope ____________________

## 3.0 ROCKS

3.1 Rock Type ____________________

3.2 Geological Formation ____________________

3.3 Rock Dip/Direction ____________________

3.4 Joint Density (no/meter) ____________________

3.5 Fracture Density (no/meter) ____________________

3.6 Schistosity Density (no/meter) ____________________

3.7 Depth of Weathered soil ____________________

## 4.0 CLIMATE

4.1 Annual Rainfall Usual ____________

this year ____________

4.2 Annual Temperature Usual ____________

this year ____________

4.3 Humidity Usual ____________

this year ____________

4.4 Name of the nearest observatory ____________

4.5 Name of the climatic region ____________

## 5.0 VEGETATION

5.1 Tree species ____________

5.2 Tree density ____________

5.3 Tree Canopy (%) ____________

5.4 Shrubs ____________

5.5 Density of Shrubs ____________

5.6 Grasses/ crops ____________

5.7 Ground cover (%) ____________

## 7.0 History (Special reference to human influence post and present)

## 8.Ø Scaled Sketch of Local Terrain.

## 3.0 SITE PARAMETER

The rate at which water can travel through the soil depends on the character of soil. Therefore, it is necessary to carryout exercises to define the state of soil profile. Soil profile parameters which affect infiltration are, depth of differrent soil horizons, soil texture, soil water state stoniness, soil structure and plant root density etc., This exercise is intended to introduce you to some of the methods used for identification of soil parameters quickly at the site. In the following paragraphs, some descriptions are provided for the guidance and this could be supplimented by details with your own explanations and analyses.

## 1.0 SOIL HORIZONS

The parent material of soil is usually weathered rock which contains decayed organic matter. Parent material may also be loose material, river gravel or sheet wash material. In these deposits, differential deposits, differential weathering, the movements of water, and the growth and decay of vegetation at the soil surface, result in the soil developing a layered appearance, These layers are called soil horizons. Figure.1 displays a typical soil profile and its different horizons.

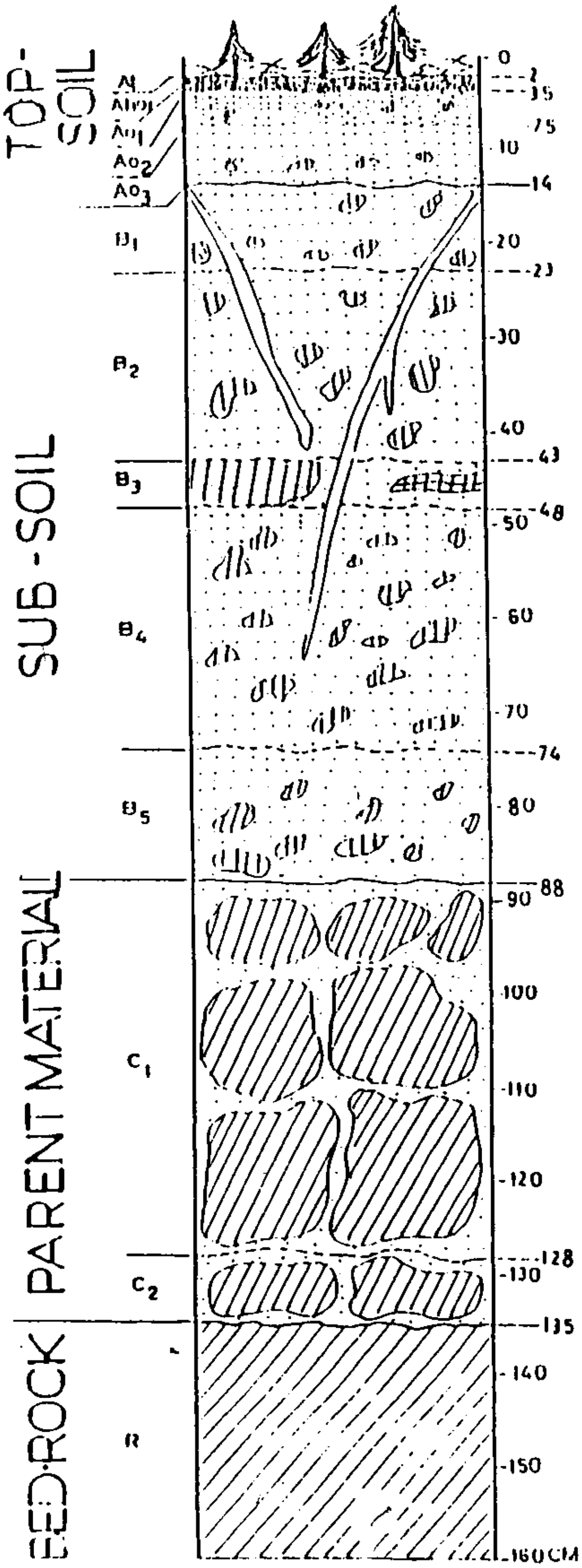



Fig. 1. Different horizons of soil.

EXERCISE -1: Make a sketch of soil profile at or near your infiltration test site after the fashion of figure 1. Take a whole page. Be very careful to make sure that you identify all the horizons in the soil.

## 7.0 SOIL TEXTURE

Textural analysis of soil is a protracted and quite complicated laboratory procedure, however, there is a simple rule of thumb method for classifying soil in the field.

Pick up a small piece of soil, Moisten it and roll it between your figure.

* If the soil feels coarse and gritty, ano if coarse grains are clearly visible, then you have a SANDY SOIL.

* If the moistened soil feel smooth, but not sticky, then you have a SILTY SOIL.

* If the moistened soil is sticky, and it can be moulded, that is rolled out into a little string that will hold together, then you have a CLAY.

Thus, with the help of 'Wet' method or method of rolling you can determine the texture of soil as presented in figure 2.

EXERCISE - 2: Try to identify the texture of each soil horizon and name them in your sketch of soil profile prepared during exercise 1.

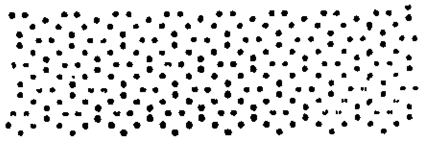
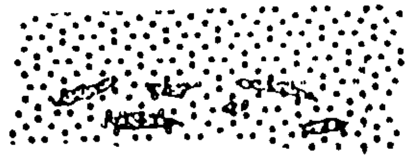
| Texture | View of sample in plane projection after rolling |
|---|---|
| No roll forms - sand |  |
| Beginnings of a roll - sandy loam |  |
| The roll breaks during rolling - light loam |  |
| The roll is continuous, but breaks when a ring is formed medium loam |  |
| The roll is continuous, but the ring dracks - heavy loam |  |
| The roll is continuous, the ring is whole - clay |  |

Fig..2. Criteria of the 'wet' method for determining soil

## 3.0 SOIL WATER STATE

The feel of a soil changes with its soil moisture content. So the field soil texture test can be turned mind you can use a similar method to determine the soil moisture. Table 1 (U.S.D.A Soil Conservation Service, Oregon, Technical Note, Agronomy US 1982) is a chart designed to help technicians estimate soil moisture. The chart was developed in field tests with mechanical and electronic soil moisture meters.

EXERCISE - 3: Attempt to estimate the soil moisture content of each soil horizon by means of the chart supplied.

## 4.0 STONINESS

The size and abundance of stones should be described at the infiltration test site using the following criteria.

<u>4.1 Stone Size</u> - The size of the fragments should be estimated using the scale:

| | |
|---|---|
| Very small stones | 2-6 mm |
| Small stones | 6mm-2cm |
| Medium stones | 2-6 cm |
| Large Stones | 6-20 cm |
| Very large stones | 20-60 cm |
| Boulders | 60 cm. |

| Percent Available Moisture | Medium Soil Texture |
| --- | --- |
| Saturated Soil | Free water is easily seen on the soil surface. The soil is shiny, very sticky, clings to hand. When shaken in an open band, moisture will flow to the soil surface and the soil will flatten out. Muddy water may flow between the fingers after the soil is shaken.<br>Ribbon test: Will not ribbon or roll into pencil shapes. |
| Field Capacity<br>100 | Ball test: Wet, sticky, doughy and slick. A very plastic ball is formed, handles like stiff bread dough or modeling clay; not muddy. Leaves water on hand. Just barely squeeze moisture out of soil, but not muddy. Ball will change shape and cracks will appear before breaking.<br>Ribbon test: Ribbons readily with slight pressure to 1 inch before breaking.<br>Open palm test: Forms a tight ball. Will work into a long, round pencil-like shape. |
| 85–95 | Ball test: Moist and somewhat slick. Wet outline left in hand. No free water on soil surface. It is somewhat plastic and holds together when tossed 15-18" and caught in open hand.<br>Ribbon test: With slight pressure, ribbons out to 3/4 inch before breaking.<br>Open palm test: Forms a firm ball with slight pressure. When made into a pencil shape then rolled, it cracks and breaks apart. |
| 70–80 | Ball test: Damp and heavy; slightly sticky when moderately squeezed. Forms tight plastic ball. Shatters with a burst into large particles when broken. Hand is moist.<br>Ribbon test: Pressure—ribbons easily to 3/4"; soil slick with definite moisture imprint on finger. Slight pressure—ribbons 1/2 inch. Moist soil particles left on thumb.<br>Open palm test: Sample can be molded into a round ball; somewhat plastic, will not shatter readily. |
| 60–65 | Ball test: Form firm ball; main line of finger joints will be imprinted on ball. Irregularities can be brushed off. No moisture on hand, just damp feeling. Soil doesn't stick to hand. Ball is pliable, not easily broken. When broken under sudden pressure, ball shatters or falls into medium-size fragments. Ball tossed 18" and caught in open hand breaks on impact. |
| 50–55 | Ball test: Forms a ball readily, holds its shape. No moist feeling is left on hand; a few soil fragments cling to palm. Ball is very brittle and breaks readily. Soil falls or crumbles into small granules when broken.<br>Ribbon test: With pressure will ribbon 1/4" to 3/8".<br>Open palm test: Sample very crumbly; readily dissolves into individual particles. Soil tossed 18" and caught in open palm breaks into several pieces.<br>Soil is lighter colored. |
| 35–45 | Dry, almost powdery.<br>Ball test: A ball can be formed under pressure, but some soil will fall or flake away when hand is opened. The ball is very crumbly and hardly holds its shape. |
| 25–30 | Dry, somewhat powdery.<br>Ball test: Will form a weak ball under pressure, crumbles readily when hand is open with only 1/3 of ball holding shape; the rest crumbles.<br>Soil is light colored and, except for hard lumps, it is single grain. |
| Below 20 | Powdery, dry, will not form a ball. If soil is crusted, it is easily broken into a powdery condition. |

## DEFINITION OF TESTS

| | |
| --- | --- |
| 1. Ball test: | Ball formed when a handful of soil is squeezed hard in fist. Observe effect when broken between thumb and forefinger. |
| 2. Ribbon test: | Pressure - soil is squeezed out between thumb and forefinger for ribboning effect. Squeezing must be done with a ¼ to ½" sliding motion of the thumb<br>Slight pressure - same as above except thumb and finger are kept 1/8 inch apart. |
| 3. Open palm test: | Ball of soil rolled gently between open palms to note effect. |

NOTE: [illegible] will feel 5-10 percent dryer than the actual condition.

Soils that are compacted will need to be checked by the amount of moisture left on the hand.

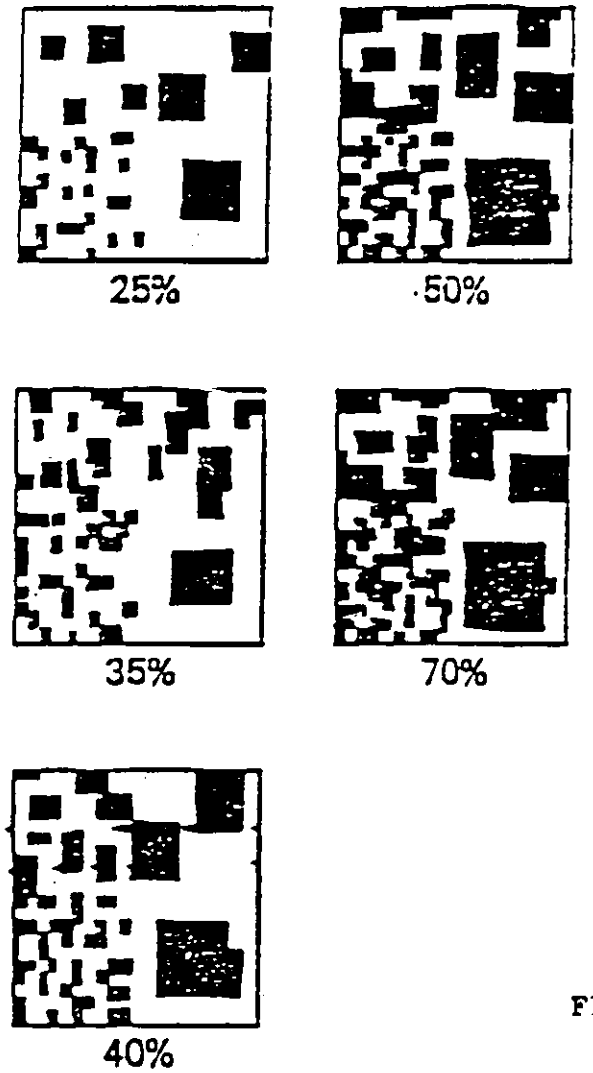
4.2 Stone Abundance - The percentage by volume of stones, etc. should be estimated by eye using the chart as shown in figure 3. The following scale of stone abundance is used;

| | |
|---|---|
| Stonless | < 1% |
| Very slightly stony | 1-5% |
| Slightly stony | 6-15% |
| Moderately Stony | 16-35% |
| Very stony | 36-70% |
| Extremely stony | > 70% |

EXERCISE - 4: Try to estimate the stone size and stone abundance in each soil horizon of the soil profile at the test site.

## 5.0 SOIL STRUCTURE

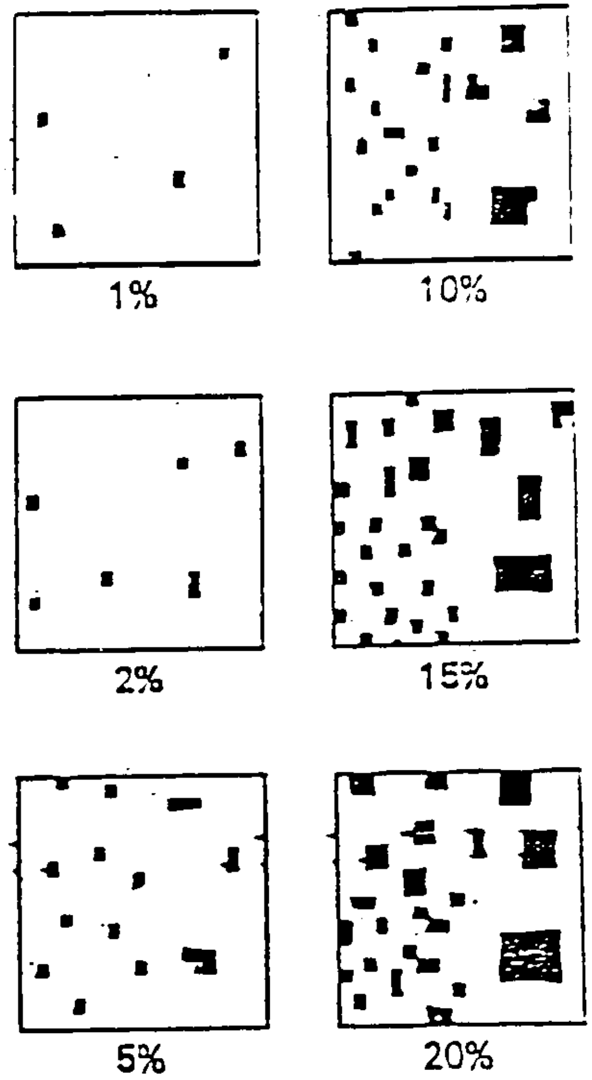
Soil structure refers to the shape, size and degree of development of the aggregation. Soils are composed of two types of particles. These are simple mineral particles and agglomeration of small mineral particles often mixed with humus. These agglomerations or soil crumbs, are called soil aggregates. They are very important in passing down water since they affect the capacity and infiltration rate. Soil aggregates are termed as peds of different shape and size. The peds are characterised by pores and fissures which help in vertical movement of infiltrated water. Let us consider these one by one.




Each quarter of any one square
has the same area of black

Chart for estimating mottles, stones, nodules etc.

FIG. 3.




Each quarter of any one square
has the same area of black

Chart for estimating mottles, stones, nodules, etc.

5.1 Shape and Size of Peds. The peds are of two types. In the upper layers, they may be coarse, porous granular. Lower down they may have well-formed, even shiny faces. They may be coated with organic material, even plant roots. Table 2 and charts (Fig.4) are attached which will help you to describe the peds size and shape.

If peds are indistinct or incoherent and easily broken they are WEAKLY DEVELOPED. If they are obvious in undisplaces oil, stick to each other, break clearly into smaller peds, and if disturbed soil consists of firm peds entirely, they are STRONGLY DEVELOPED Intermediate peds are MODERATELY DEVELOPED.

EXERCISE -5: Identify and describe the peds in your infiltration test site. Describe the size and shape in the soil. Locate your notes on the soil profile sketh (exercise - 1).

5.3 Pores - Pores are divided into micropores (< 60 um diameter) and macropores ( > 60 um diameter). Only macropores can be seen by naked eye. Holes, tubes or burrows (macropores) within the soil masses are classed as follows.

| Class | Diameter (in mm) |
|---|---|
| Very fine | 0.5 mm |
| Fine | 0.5-2 mm |
| Medium | 2-5 mm |
| Coarse | > 5 mm |

Granular Peds

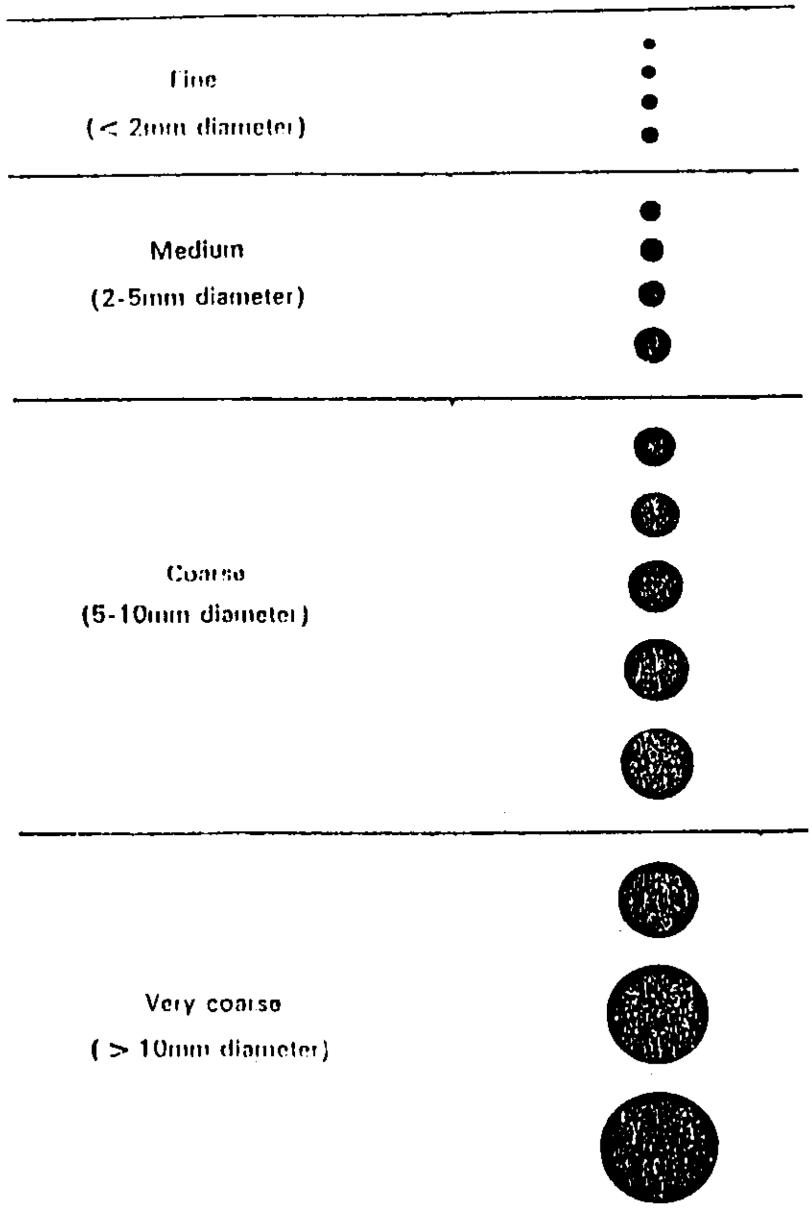



FIG. 4

Prismatic and Columnar Peds

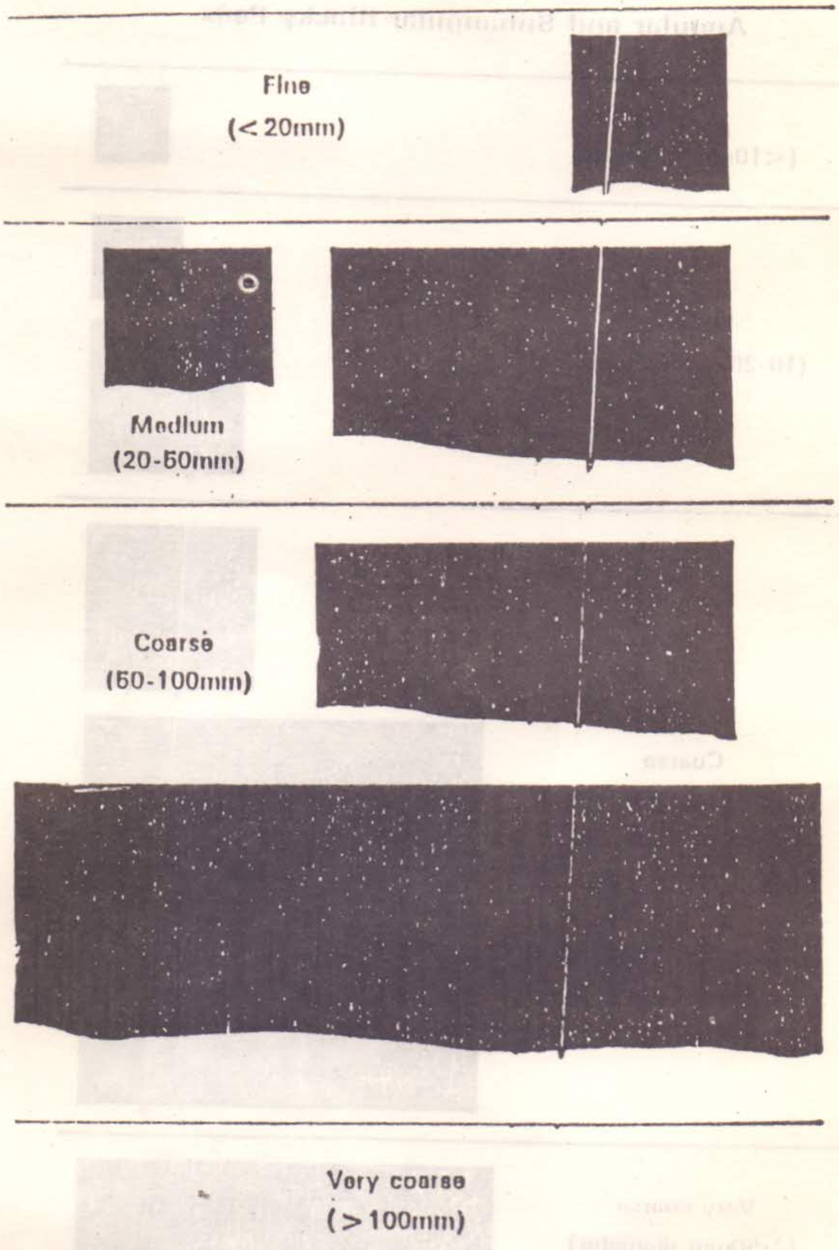
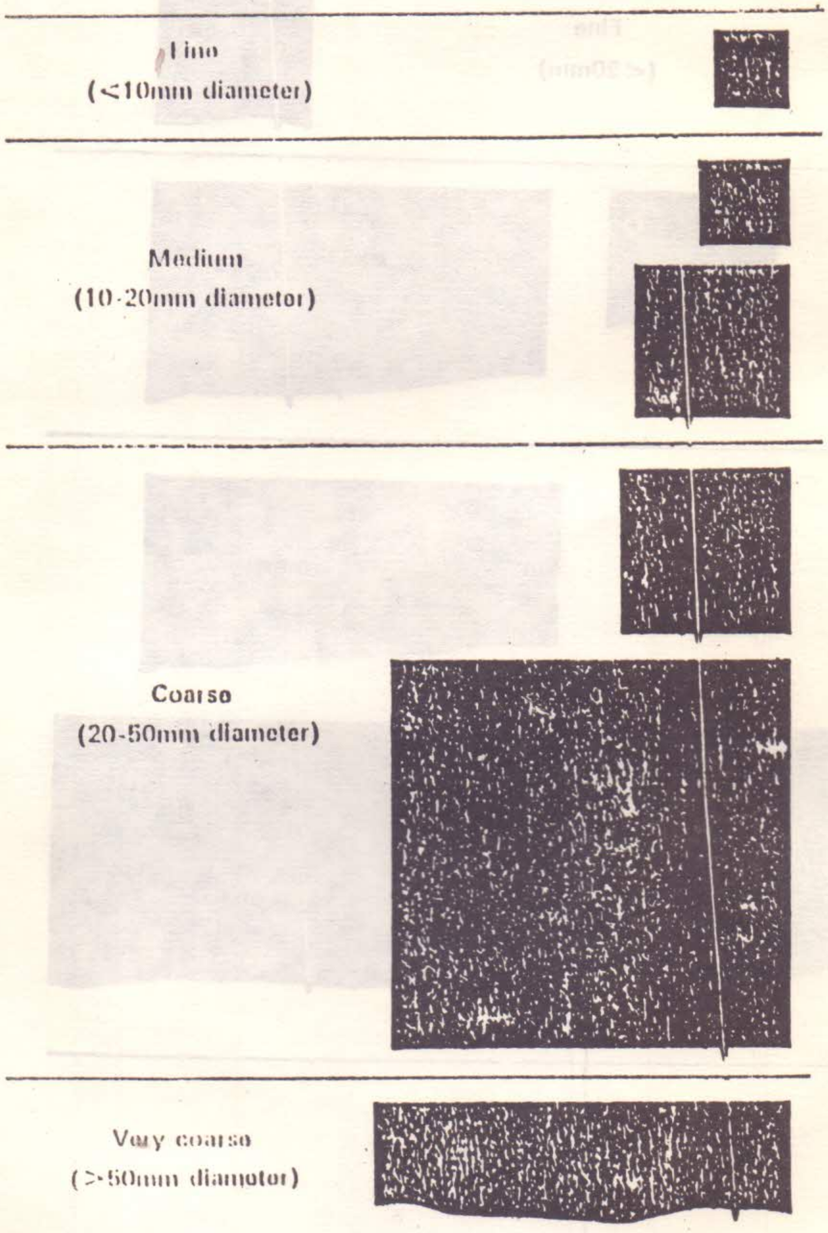



FIG. 4

## Angular and Subangular Blocky Peds



Platy Peds

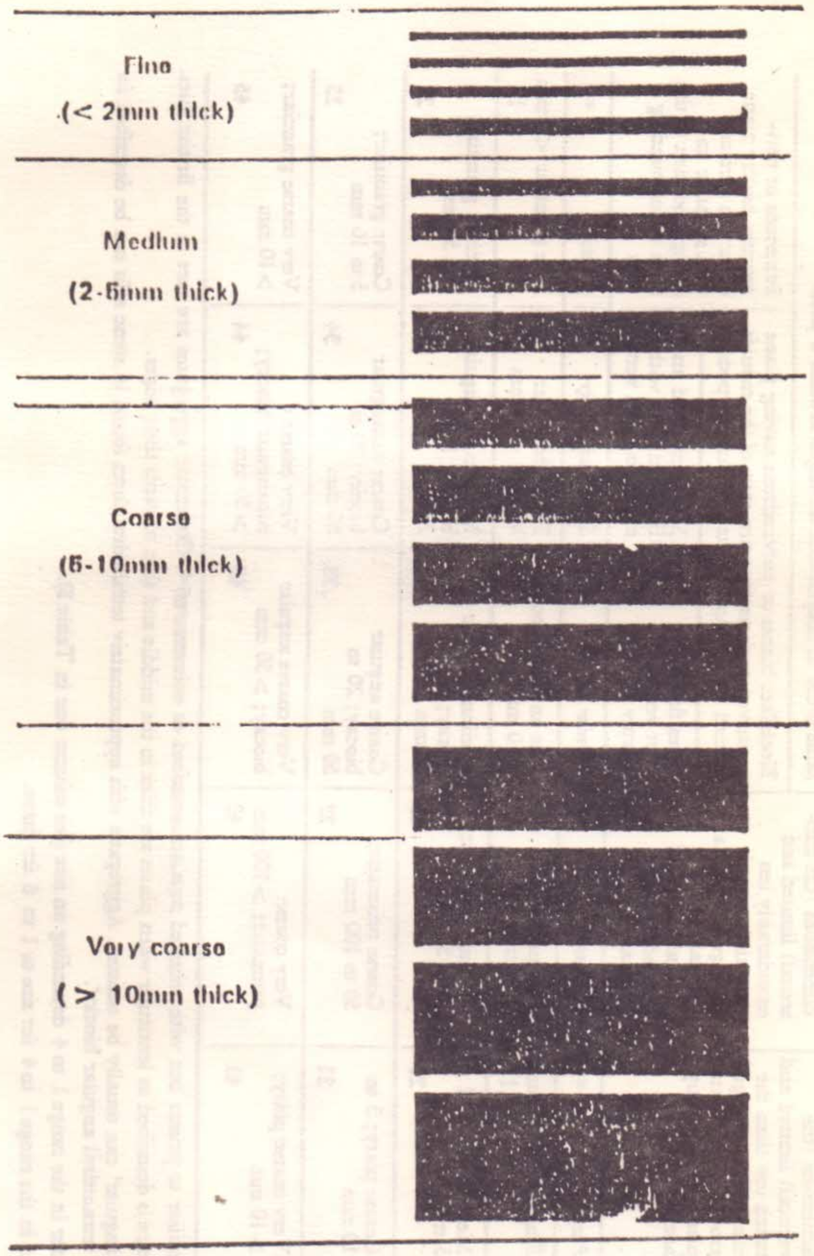



Fig. 4

Table 2 . **Size and Shape of Peds and Fragments**

| Size | *Shape and arrangement of peds and fragments* | | | | |
|---|---|---|---|---|---|
| | Platelike with one dimension (the vertical) limited and much less than the other two; arranged around a horizontal plane; faces mostly horizontal | Prismlike with two dimensions (the horizontal) limited and considerably less than the vertical; arranged around a vertical line; vertical faces well defined; vertices angular | Blocklike: polyhedronlike or spheroidal, with three dimensions of the same order of magnitude, arranged around a point | | |
| | | | Blocklike: blocks or polyhedrons having plane or curved surfaces that are casts of the moulds formed by the faces of the surrounding peds | | Spheroids or polyhedrons having plane or curved surfaces with slight or no accommodation to the faces of surrounding peds |
| | | | Faces flattened; most vertices sharply angular | Mixed rounded and flattened faces with many rounded vertices | |
| | *Platy*[1] •1 | *Prismatic* •2 | *Angular blocky*[2] •3 | *Subangular blocky* •4 | *Granular* •5 |
| *Fine* 1• | Fine platy; <2 mm 11 | Fine prismatic; <20 mm 12 | Fine angular blocky; <10 mm 13 | Fine subangular blocky; <10 mm 14 | Fine granular <2 mm 15 |
| *Medium* 2• | Medium platy; 2 to 5 mm 21 | Medium prismatic; 20 to 50 mm 22 | Medium angular blocky; 10 to 20 mm 23 | Medium subangular blocky; 10 to 20 mm 24 | Medium granular; 2 to 5 mm 25 |
| *Coarse* 3• | Coarse platy; 5 to 10 mm 31 | Coarse prismatic; 50 to 100 mm 32 | Coarse angular blocky; 20 to 50 mm 33 | Coarse subangular blocky; 20 to 50 mm 34 | Coarse granular; 5 to 10 mm 35 |
| *Very coarse* 4• | Very coarse platy; >10 mm 41 | Very coarse prismatic; >100 mm 42 | Very coarse angular blocky; >50 mm 43 | Very coarse subangular blocky; >50 mm 44 | Very coarse granular; >10 mm 45 |

Aggregates similar to prisms but with rounded tops are described as columnar[6]. Columnar aggregates are rare in the British Isles.
[1] Platy structure is described as lenticular when plates are thick in the middle and thin towards their edges.
[2] The word 'angular' can usually be omitted. Aggregates with approximately tetrahedral form found in some soils can be described for example as 'tetrahedral angular blocky'.
[3] = is a number in the range 1 to 4 depending on size (see column one in Table 3).
• is a number in the range 1 to 4 for size or 1 to 6 for shape.

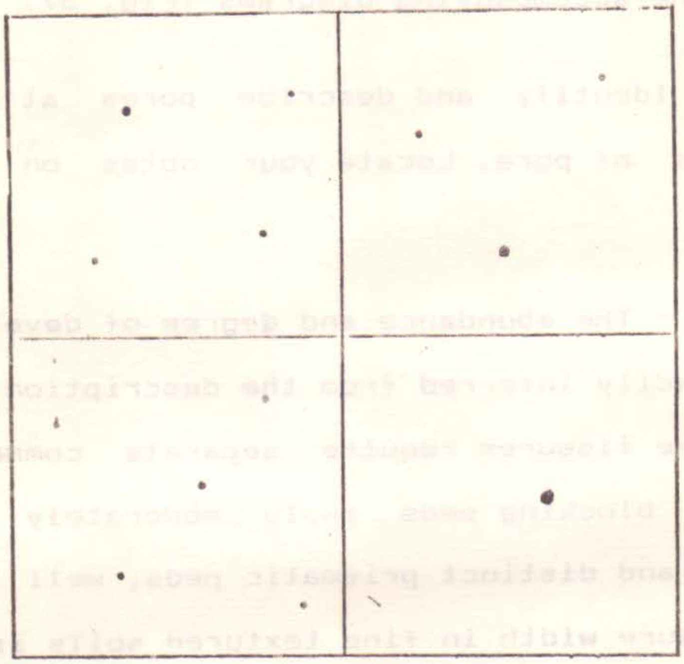
The percentage of macropores per unit area of soil mass may be estimated using the accompanying diagrams (Fig. 5).

EXERCISE - 6: Identify and describe pores at the site. Specify the classes of pore. Locate your notes on the soil profile sketch.

5.3 Fissures - The abundance and degree of development of fissures is often readily inferred from the description of peds. only fine to coarse fissures require separate comment, Thus, moderately distinct blocking peds imply moderately developed irregular fissures, and distinct prismatic peds, well developed vertical ones. Fissure width in fine textured soils is largely determined by moisture content, and varies with depth and season. Fissures between peds and clodes and fragments may be described using the following scale:

| Class | width in mm |
|---|---|
| Very fine | 0- 1 |
| Fine | 1- 2 |
| Medium | 3- 5 |
| Coarse | 5-10 |
| Very coarse | > 10 |

EXERCISE-7: Identify and desirable the fissure in the soil at the site using above scale. Locate your notes on the soil profile



0.1%

. Percentage pores.

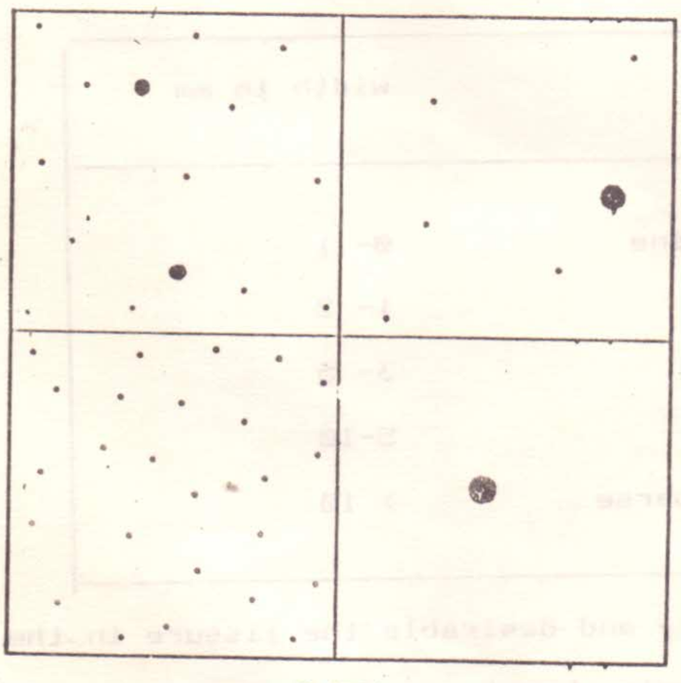
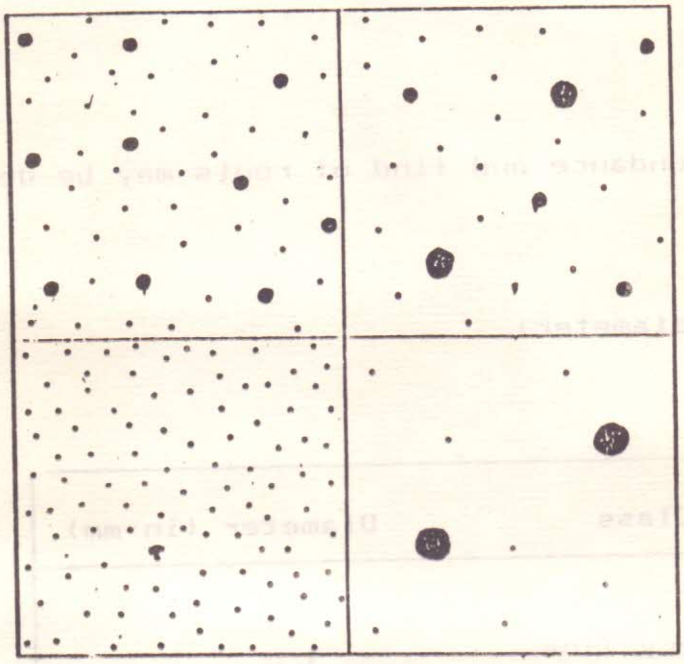


FIG. 5. 0.5%

. Percentage pores.



2%
. Percentage pores.

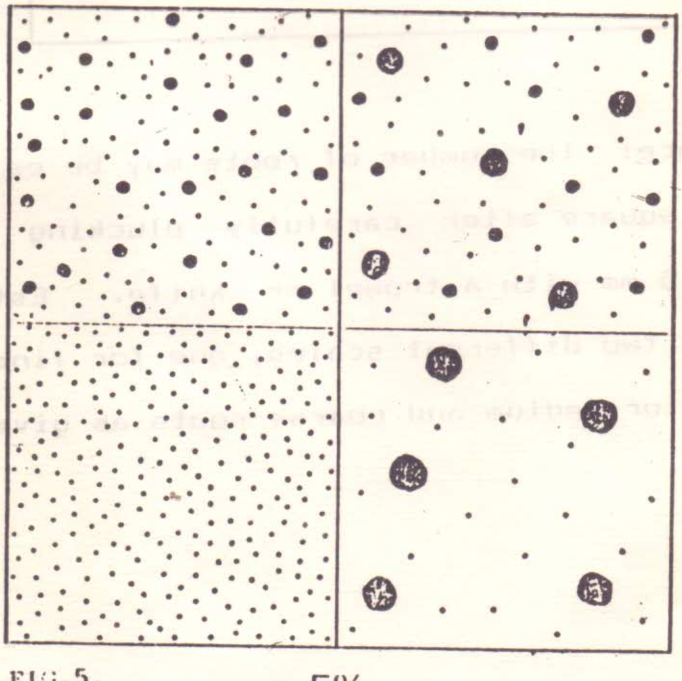


FIG.5.

5%
. Percentage pores.

## 6. ROOTS

The size and abundance and kind of roots may be described as indicated below.

6.1 Root size (diameter)

| Class | Diameter (in mm) |
|---|---|
| Very fine | 1 |
| Fine | 1-2 |
| Medium | 2-5 |
| Coarse | 5 |

6.2 Root Abundance: The number of roots may be estimated in areas about 100 cm square after carefully plucking back the profile face about 5 mm with a trowel or knife. Estimate of abundance are made on two different scales, one for fine and very fine roots and other for medium and coarse roots as given below.

| Abundance of Roots | | |
|---|---|---|
| Frequency Class | Number of roots per 100 cm | |
| | Very fine & fine roots | Medium and coarse roots |
| Few | 1-10 | 1 or 2 |
| Common | 10-25 | 2 - 5 |
| Many | 25-200 | 5 |
| Abundant | 200 | ---- |

EXERCISE: 7 Identify the root size and estimate the undance of roots. Locate your notes on the soil profile sketch d mention these information.

# .0 INFILTRATION TEST

Owing to the complexity of the infiltration phenomenon, and the fact that many factors affect the process, the measurement of infiltration rates and volumes should be accomplished under field conditions. Two methods are there in common use for the purpose, (i) infiltrometers ; and (ii) hydrograph analysis where the hydrograph of the observed runoff resulting from periods of natural rainfall on a watershed is studied analysed. However, infiltometers (double ring) are most commonly used instruments for measuring infiltration rate under the field conditions.

Infiltration rates in soils and rocks can be determined in several ways. Laboratory determination involve placing soil or rock cores in suitable containers and allowing water to percolate through known soil cross-sections. unless soils are equigranular and loose, laboratory values may differ from values obtained in the field. Field determination under continuous soil saturation conditions are made by impounding water in experimental plots or allowing water to drain into pans or lysimeters placed below the soil surface. Sprinklers of various designs are used to create artificial rainfall experimental plots and infiltration rates for specified duration are deduced from the rate of rainfall and runoff. From a drainage basin, the rate of infiltration can be approximated if duration , amount and intensity of precipitation as well as interception , depression storage, evaporation and surface runoff are known.

Single infiltrometer rings are also used, but they are apt to give erroneously large values of infiltration rates due to the sponging effect of the soil material outside the cylindrical section of the soil below the ring. Turbulence of water should be avoided as otherwise, finer particles in the soil may get suspended and subsequently settle down in a thin veneer and reduce the infiltration rate.

**Double Ring Infiltrometer:**

In recent years, for the determination of infiltration rate, double ring infiltrometers are widely used. Infiltration characteristics of soils may be determined by ponding water in a metal installed on the field surface and observing the rate at which water level is lowered in the ring. In the single ring infiltrometers, a wide variation of data are observed, The variability could be due to the uncontrolled lateral movement of water from the ring after the wetting front reached the bottom of the ring. In the double ring infiltrometer these problems are solved. The experimental set-up is shown in figure 6. This consists of two concentric rings,(45 cm and 30 cm in diameter or 42.5 cm and 27.5 cm in diameter) made up of mild steel plates, and a couple of tanks with the same diameter as that of the rings to feed water into the rings to maintain constant head of water. A constant depth of water can be maintained by suitably adjusting the position of the nozzle of the tube which is connected to the water container. The experimental part involves the following steps.

(1) Selection of the site : Site selection should be based on the rock types, soils,vegetation and rainfall intensity.

(2) Once the suitable site is selected,instruments will be set-up as shown in the figure 6. Initially , two rings of about 40 cm deep (thickness 2-3 mm) and of suitable diameter (outer and inner rings) should be selected,

(3) The rings must be driven about 20 cm deep into the soil.

(4) Two constant head devices with a marking of maximum water level will be lowered in to both the rings (inner and outer) through a flexible pipe and in turn this should be connected to the graduated container. There will be a nozzle for controlling the water flow from the container. Constant head device (float) will aid in maintaining the water level and to note the readings.

(5) In the next stage water will be supplied from the container tube. The minimum water level in the rings should be upto a depth of 10 cm. The fall of water level in the tanks corresponds to a depth of water infiltrated However, use of containers can be dispensed with and measurements of depth of water infiltrated and water replenished in the ring to a pre-determined level can be made by use of scale or by graduating the rings.

(6) The readings may be taken at definite intervals (0,10,10, 10, 20, 20, 30, 30, 30, 60 , time in minutes) till we get a constant reading.

(7) Finally, a graph may be drawn with time on X-axis and infiltration rate on Y-axis, (Fig. 7 ).

Precautions to be taken while using double ring infiltrometer

(1) Diameter of the containers and rings should be the same,

(2) The distance between the rings should be maintained equally on all sides.

(3) Disturbance in soil layers should be a minimum.

(4) Water level in the inner cylinder and the buffer pond should be equal.