IRRIGATION CHARACTERISTICS OF SOILS IN THE MAREEBA-DIMBULAH AREA OF NORTH QUEENSLAND

2. INFILTRATION AND RELATED DATA FOR THE CRAIG LOAMY SAND

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SUMMARY

Soil moisture relationships and infiltration characteristics of the Craig Loamy Sand are discussed and techniques used in these investigations are described. A description of the soil profile and general topographical features of the locality is also given.

I. INTRODUCTION

During 1960 from April to August infiltration studies were conducted on the soil type described in Departmental Soil Survey Reports as the Craig Loamy Sand (Type 47). This soil occurs in the vicinity of Craig Creek in the Left Bank Walsh area to the west of Mareeba. Unbuffered ring infiltrometers were used to determine the soil's infiltration characteristics.

A portion of this area was opened up for the growing of tobacco under irrigation during the 1960-61 season. The soil's nutritional requirements and general cropping ability had previously been investigated by officers of the Department of Agriculture and Stock stationed at Parada Tobacco Experiment Station. To supplement the data obtained, the absorption rate and moisture retaining properties of the soil were examined.

II. SOIL DESCRIPTIONS

The Craig Loamy Sand occupies approximately 700 ac in an area between Fumar and Chircan on the Mareeba-Dimbulah road. The topography varies in slope from 2·5 to 5.0 per cent. and in places is dissected by small watercourses which flow only during the wet season. In this locality the annual rainfall is about 32 in., 84 per cent. of which falls between December and March.

The vegetation consists principally of long-leafed box (*Eucalyptus leptophleba*) and bloodwood (*E. intermedia*), with pandanus (*Pandanus* spp.), flame tree (*Brachychiton paradoxum*) and broad-leafed tea-tree (*Melaleuca nervosa*) also occurring. In places white cypress pine (*Callitris glauca*) is quite common. *Panicum decompositum* provides the principal grass cover.

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PROFILE DESCRIPTION (Figure 1)

(This description was compiled near the test area.)

Horizon	Depth (in.)	
A1	0- 3	pale brown fine loamy sand.
A2	3-14	pale yellow fine loamy sand.
B1	14-38	yellow sandy clay loam, concretionary.
B2	38-60	red and yellow mottled sandy clay.

Some concretions and a few large stones are present in the upper part of the B1 horizon, and below 28 in. there is a concentration of concretionary material approximately 10 in. thick above the sandy clay. Throughout the area the sandy clay layer varies in occurrence from the surface, with the shallowest observed depth being 2 ft.

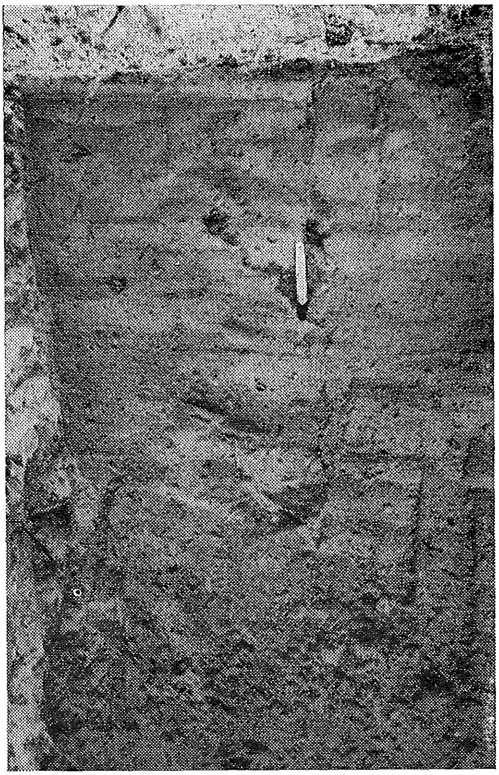

Fig. 1.—Soil profile of Craig Loamy Sand, showing concretionary material in lower B1 horizon.

III. METHODS

All investigations on the Craig Loamy Sand were confined to a virgin area of 0·1 ac to conform with the areas selected on other soil types where similar studies were made.

(1) *Infiltration Studies*.—The measurement of infiltration rate *in situ* usually involves either the surface ponding of water or the spraying of water onto the surface at a rate sufficient to cause run-off. On the Craig Loamy Sand a pondage method using 9 in. x 12 in. dia. unbuffered rings was employed. This method (Stirk 1951) was used as both water and equipment had to be transported considerable distances. Also it was considered that rates obtained by this method could be applied to furrow irrigation.

The soil was first cleared of all vegetation and hand-cultivated over an area of 2 ft square to a depth of 3 in. This procedure was adopted as the infiltration trials were being conducted on a soil which was to be cultivated in practice. The ring was then driven through this loosened layer and into 2 in. of the undisturbed subsoil. A constant head of water was maintained within the ring by a "spreader" connected to the outlet pipe of the infiltrometer drum. Attached to the side of the drum was a glass tube and scale enabling the water level to be read periodically. The set-up of the equipment is shown in Figure 2.

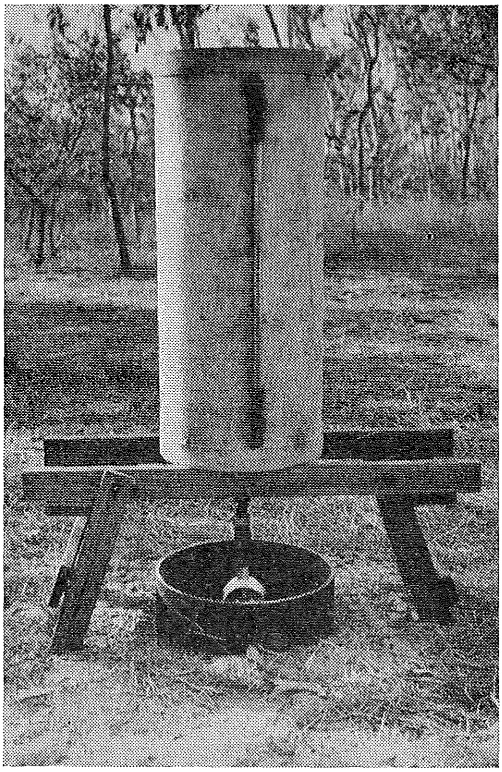

Fig. 2.—Infiltrometer for measuring infiltration rates of soils.

In these studies, eight infiltration trials were conducted on the selected area. Each trial consisted of running six infiltrometers simultaneously on a particular date. The trials were run for periods of approximately 6 hr, but one trial was run for 12 hr to ascertain if there was any appreciable drop in infiltration rate over the prolonged period. The six infiltrometers were placed in two rows about 12 ft apart, with 12 ft spacings within the rows.

Soil samples were taken for the gravimetric determination of soil moisture prior to the commencement of each trial. Four sets of samples were collected within the test area at 4 in. depths to at least 40 in. and the average of these was taken as the antecedent soil moisture. During the period the eight trials were conducted the antecedent soil moisture decreased from 4 per cent. to 1 per cent. within the surface foot.

(2) *Field Capacity*.—Field capacity was measured in the field in conjunction with infiltration trials. On completion of these trials the rings were covered to prevent evaporation. Preliminary studies had indicated that the most suitable time for soil sampling down the wetted profile was 24 hr after the completion of infiltration trials and this sampling time was adhered to throughout the duration of these studies.

A 1·5 in. dia. tube was used for collecting soil samples from within the centre of each ring at 4 in. depths to the maximum depth of water penetration. The figures obtained down the moistened profile to within 8 in. of the wetted front were taken as being representative of the soil's field capacity. In infiltration tests the applied water frequently penetrated to a depth of at least 36 in.

(3) *Wilting Point*.—The area of 1 chain square was divided into 8 equal portions. From within each portion two samples were taken per horizon with a 4 in. Jarret head auger and bulked, and a single determination was made on each sample after it had been passed through a 2 mm sieve. The sunflower method (Piper 1950) was used to obtain the permanent wilting point.

(4) *Bulk Density*.—A 4 in. Jarret head auger was used to excavate soil in 8 in. depth intervals to 24 in. The excavated soil was oven-dried and weighed and the dimensions of the auger hole determined. Altogether six measurements of bulk density were made at each depth from within the selected area.

(5) *Soil Texture*.—Mechanical analyses were carried out on soil samples collected from the main horizons within the surface 3 ft. For these determinations the Bouyoucos hydrometer method (Piper 1950) was used.

IV. RESULTS

(a) Infiltration Studies

The infiltration rate has been defined by a committee on terminology (Richards 1952) as: "The maximum rate at which a soil, in a given condition at a given time, can absorb rain. Also, the maximum rate at which a soil will absorb water impounded on the surface at a shallow depth when adequate precautions are taken regarding border or fringe effects". It is commonly expressed in inches per hour.

By definition, infiltration rate refers to the rate at which water enters the soil, with due allowance being made for lateral spread. Marshall and Stirk (1950) described a method for correcting the minimum infiltration rate for lateral spread in small unbuffered plots. The corrected minimum infiltration rate is obtained by multiplying the actual minimum rate by the fraction of water retained directly beneath the ring.

The degree of lateral spread beneath unbuffered plots varies with duration of trial and soil type. On this sandy soil, lateral spread was considerable and resulted in only a small fraction of the applied water being retained under the ring. The average fraction retained at the end of 6 hr was only $0 \cdot 09 \pm 0 \cdot 02$.

The relationship between infiltration rate and time for the Craig Loamy Sand is presented in Figure 3, which shows the mean of the eight trials. The use of the factor 0·09 to obtain the corrected rate at all stages during infiltration is open to criticism, but the figures thus obtained enable infiltration rate, particularly minimum rate, of different soils to be compared, as the effect of lateral spread has been taken into account.

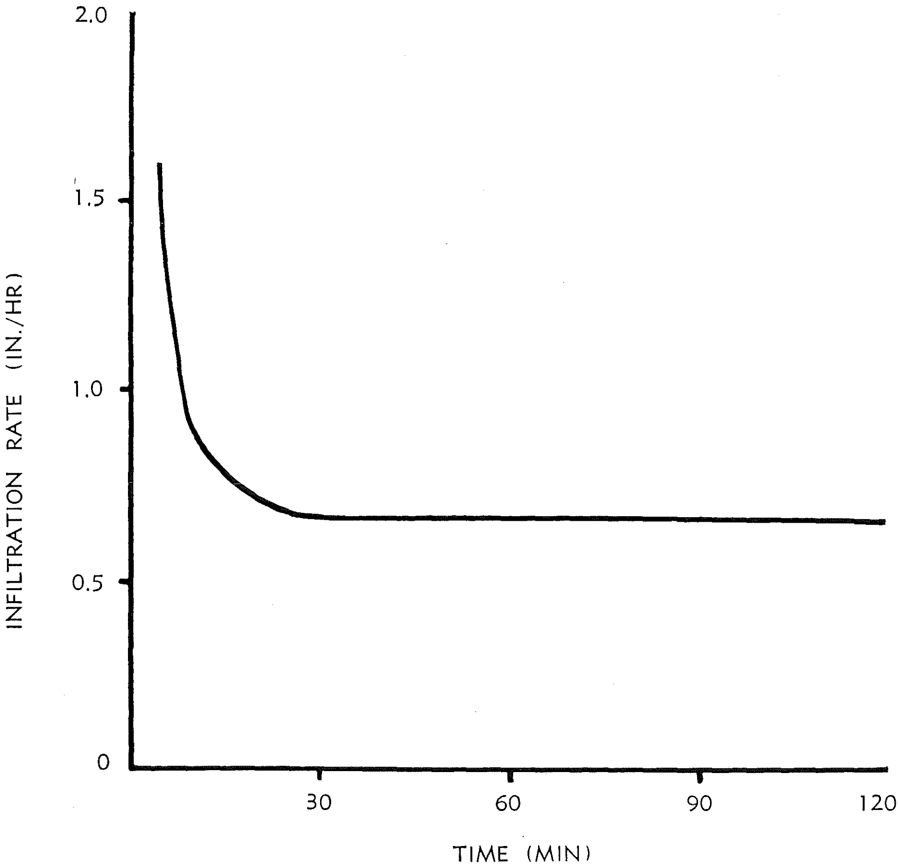

Fig. 3.—Corrected infiltration rate during period (in./hr).

Figure 3 shows the change in infiltration rate over the first 2 hr, which would be the most important period in irrigation practice. A comparatively steady rate is reached within half an hour of the initial wetting of the soil and this rate remains relatively constant for up to 6 and 12 hr. The minimum corrected infiltration rate measured was 0·67 in. per hr.

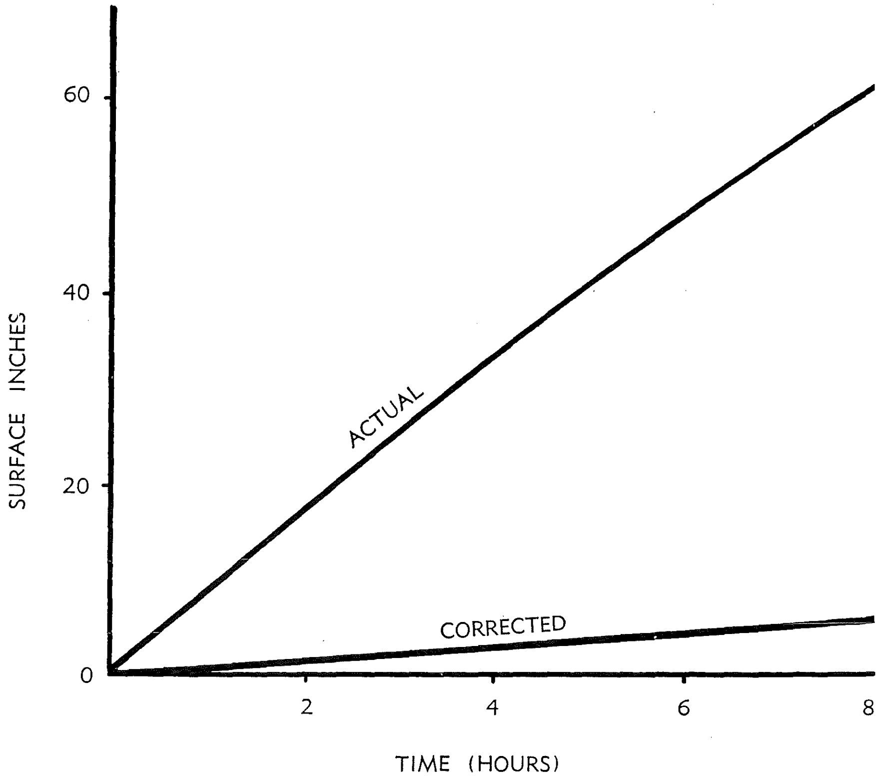

Fig. 4.—Accumulated intake.

Another aspect of the infiltration process is the total amount of water which enters the soil within a certain time interval. The graph of accumulated intake plotted against time (Figure 4) tends to continue to rise linearly for periods up to 12 hr without flattening out to any extent.

In conjunction with these infiltration trials, the moisture distribution below the ring was determined after varying amounts of water had been applied at the surface. The extent of water movement was ascertained either by exposing a vertical face of the wetted profile or by taking soil samples across the centre of the test plot.

The position of the wetted front 24 hr after applying different amounts of water is shown in Figure 5. The fraction of water retained beneath the 12 in. ring decreased with increasing amounts of water until at the end of a 6 hr trial, when over 40 in. had been applied, only 3·6 in. were retained beneath the ring.

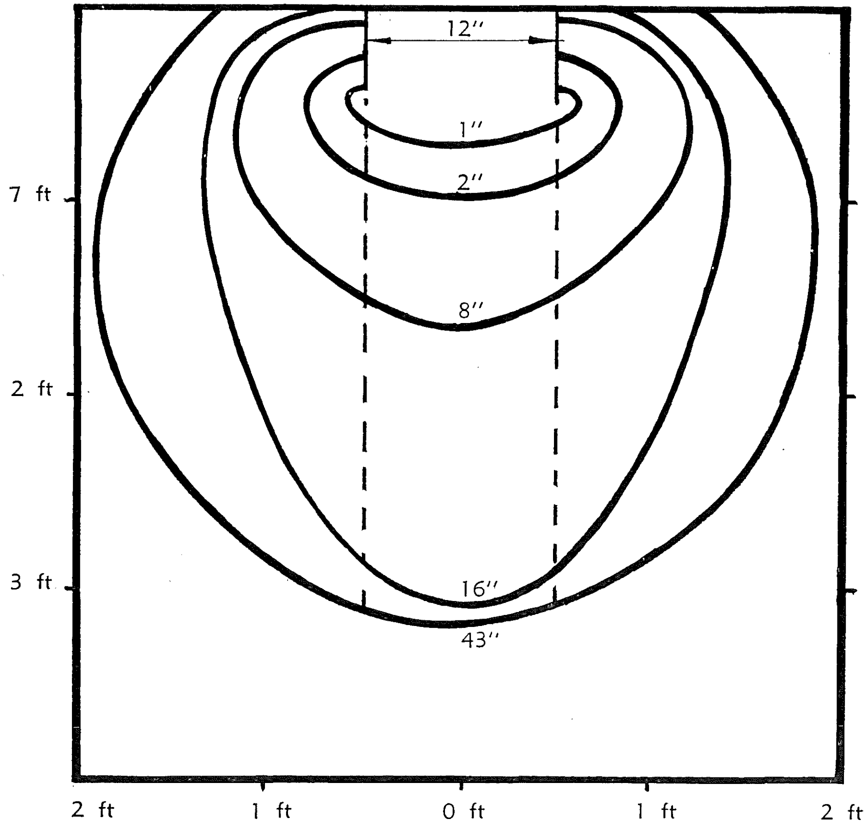

Fig. 5.—Penetration profiles in Craig Loamy Sand 24 hr after adding different amounts of water.

(b) Soil Moisture Studies

In Table 1 are presented the summarized results of available soil moisture for the Craig Loamy Sand. Although the field capacity is comparatively low (10 per cent.), there is also a correspondingly low wilting point (1 per cent.) and this results in the storage of over 1·5 in. of available moisture per foot of soil when the soil has been thoroughly wetted.

TABLE 1

AVAILABLE SOIL MOISTURE

Soil Horizon	Soil Depth (in.)	Field Capacity (%)	Wilting Point (%)	Available Soil Moisture (%)	Bulk Density (g/c.c.)	Available Soil Moisture (in./ft)
A1	0–3	10·6	1·1	9·5	1·46	1·66
A2	3–14	9·2	1·2	8·0	1·57	1·51
B1	14–38	10·3	1·1	9·2	1·60	1·76

Mean S.D.: Field capacity 0·7, wilting point 0·2, bulk density 0·08.

(c) Soil Texture

The results of the mechanical analysis (Table 2) show a slight increase of silt and clay with depth and a preponderance of fine sand over coarse sand throughout the profile.

TABLE 2

MECHANICAL ANALYSIS

Horizon	Sampling Depth (in.)	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	Texture
A1	0–3	31	60	5	4	LS
A2	6–9	29	62	4	5	LS
B1	27–30	27	57	6	10	SL

V. DISCUSSION

The corrected infiltration data presented in Figures 3 and 4 would be applicable where spray irrigation is being used as there would be only a relatively small amount of lateral spread of water under these conditions. The results indicate that a spray application rate of not more than 0·7 in./hr would be absorbed readily provided the soil surface does not become sealed.

Under furrow irrigation, where there would be a considerable amount of lateral penetration, the actual accumulated intake (Figure 4) would bear a closer relationship to field conditions than the corrected values.

The soil appears to have favourable moisture-retaining properties and a favourable infiltration rate. However, where the sandy clay horizon is near the surface (2 ft), particular attention will need to be paid to irrigation practices.

VI. ACKNOWLEDGEMENTS

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