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PRELIMINARY STUDIES ON THE USE OF NEUTRON PROBE IN SOME RUBBER GROWING SOILS

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ABSTRACT

Studies carried out on the use of Neutron Probe in soil/water relations indicate that this can be used as an effective technique in immature *Hevea* plantations. It had been possible to establish a fairly reliable calibration curve for the subsurface soil 10 – 160 cm and the calibration curve obtained is moisture content, Qv = 0.52 CR – 0.39, where CR stands for Count Ratio.

It appears that during dry period, distances varying from 0 – 1.2m from the trunk of the tree are suitable for assessing the water content of the soil profile. The available soil water storage capacity of 104.2 mm with the upper and lower limits of 235.5 and 131.3 mm, respectively, is likely to be the amount of water that is available to the plants, both rubber and covers over a period of 12 months.

INTRODUCTION

The numerous and complex factors covering a wide range of variables of the profile water balance must be known in order to understand the effect of soil moisture on plant–water relations of any plant. In this connection soil moisture contents have to be monitored regularly at a specific site. In these studies the neutron meter is used extensively to monitor soil water concerning the response of the plant to water content of the soil.

The neutron moisture meter measures the volumetric water content of the soil in a manner that satisfies the ideal requirements of agronomists. This method of measuring soil water content is a non–destructive field method based on the slowing–down by water of fast neutrons emitted by a radioactive source. The main advantages of the method compared to gravimetric sampling are those of greater precision and lower cost. When measuring the change in stored water, the most common requirement – the non–destructive attribute – requires repeated sampling in the same access hole which increases the precision of the results. The speed of sampling can also be much greater, in some situations, than with gravimetric sampling (Gardner *et. al.*, 1952; Van Bavel, 1961; Kristensen, 1973; Greacen, 1981).

This preliminary study deals with some aspects concerning the use of neutron meter technique in soil-plant-water relation studies in *Hevea*. The procedures followed are for adoption under local soil and environmental situations.

MATERIALS AND METHODS

The instrument used in this study is a Troxler Neutron Depth Moisture Gauge having a 100 milli Curie Americium/Beryllium radiation source and a Boron Triflouride detector.

Installation of access tubes

In order to avoid imposing any disturbed conditions on the soil, the hole for the access tube was made almost to the size of the access tube using a steel pipe with a cutting edge inside the pipe. To make the hole, the steel pipe was placed on the soil, a sleeve was placed on the top of the pipe and a heavy hammer was used to drive the pipe down into the soil (Fig. 1).

After inserting every 15 cm or so, the pipe was taken out and the soil was removed. Once the hole was dug to the required depth, the pipe was removed and a reaming operation was done with one access tube which was kept apart for this purpose. Once the reaming was done, a hole of almost the exact diameter of the access tube was obtained. A stopper was placed at the bottom of the access tube which was to be installed to avoid any soil or water getting inside the tube. To avoid any air gaps between the access tube and the holes dug in the soil, finely ground soil was forced into the narrow gaps with the aid of a fine jet of water from a wash bottle. A standard height of 15 cm above ground level was allowed, during installation of the access tubes. Once the tube was installed, the dummy probe was lowered into the access tube to ensure that no damage would occur to the tube during installation and that the neutron probe could go into the tube for subsequent measurements.

Calibration of neutron meter

Establishment of the basic calibration curve for the particular neutron meter, type of installation and for the general class of soil in the experimental areas is an

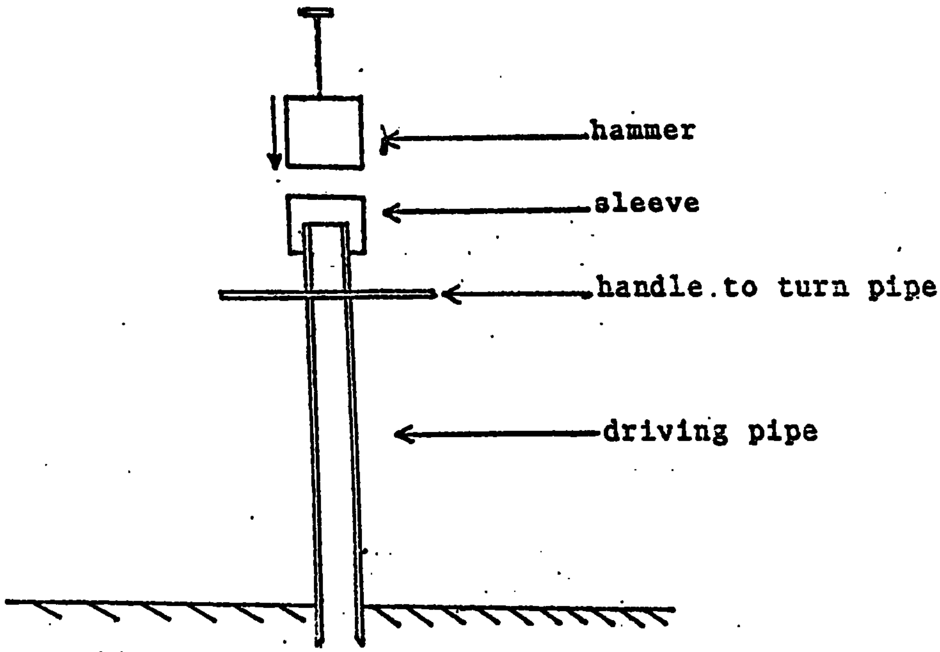

Fig. 1 Set up for driving pipe

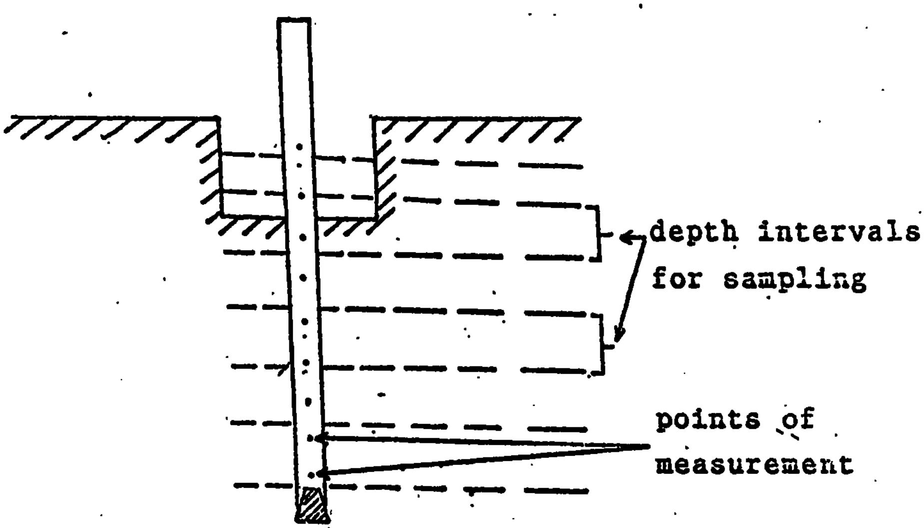

Fig. 2 Location of measurement and sampling depths for neutron probe calibration

important requirement. Field calibrations were therefore made by obtaining moisture meter readings, in duplicate at depths of 10 cm intervals from 10–160 cm (Fig. 2). For gravimetric determination of moisture content and for bulk density determination, soil samples were collected from each depth at which moisture meter readings were recorded by digging pits around each access tube.

Location of access tubes

In order to minimise sampling errors due to location and mode of installation of access tubes in the field, a pilot study was conducted to determine the most suitable position in relation to the rubber plant for the installation of access tubes. Trees were selected at random in a 3-year old replanting and access tubes were installed at distances 60, 120 and 180 cm (2,4 and 6 ft.) from the trunk of each plant in four directions, north, south, east and west, making in all 12 positions. Moisture readings were recorded weekly at depths of 10 cm intervals from 10 to 90 cm, which generally covers the rooting zone of immature rubber plants.

Soil moisture status

Some of the objectives of a measurement programme based on the neutron meter are the estimation of some complex variables of the profile water balance such as run-off and change in the soil water store. This profile water store is the difference between the upper and lower limits of water content at some specified depth, usually the root zone.

RESULTS

Calibration curves

Calibration curves obtained from 29 readings taken over a period of 12 months (Fig. 3) for the surface (0–10 cm) is;

moisture content Θ .41 CR – 0.18

and (Fig. 4) for the sub surface (10–160 cm) is;

moisture content $\Theta = 0.52$ CR – 0.39, where CR stands for Count Ratio.

Location of access tubes

Statistical calculations (co-efficient of variation) of count ratios obtained from 12 positions of access tubes in relation to planting points over a period of 12 months

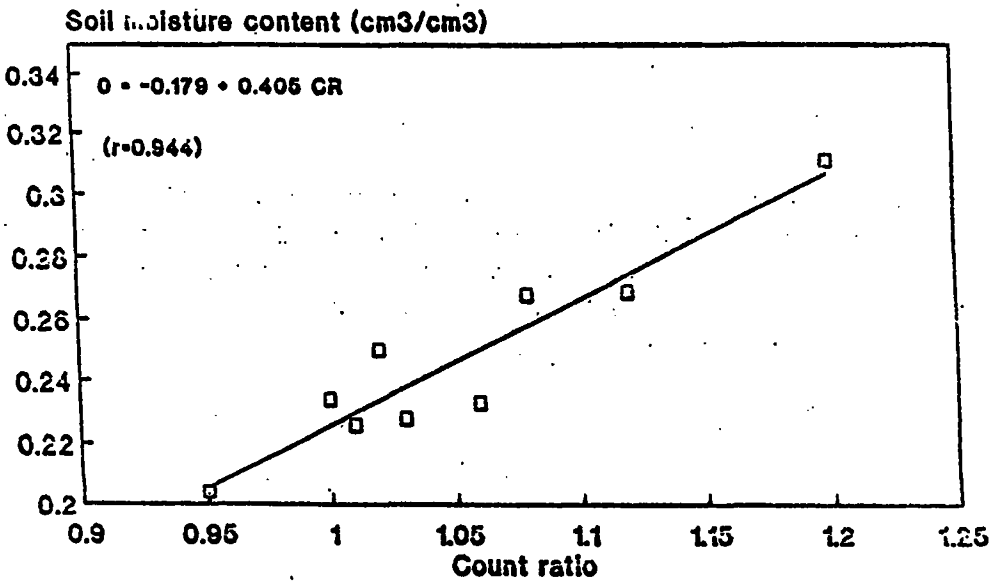

Fig. 3 Field calibration of neutron moisture meter for the surface layer, 0 – 10 cm

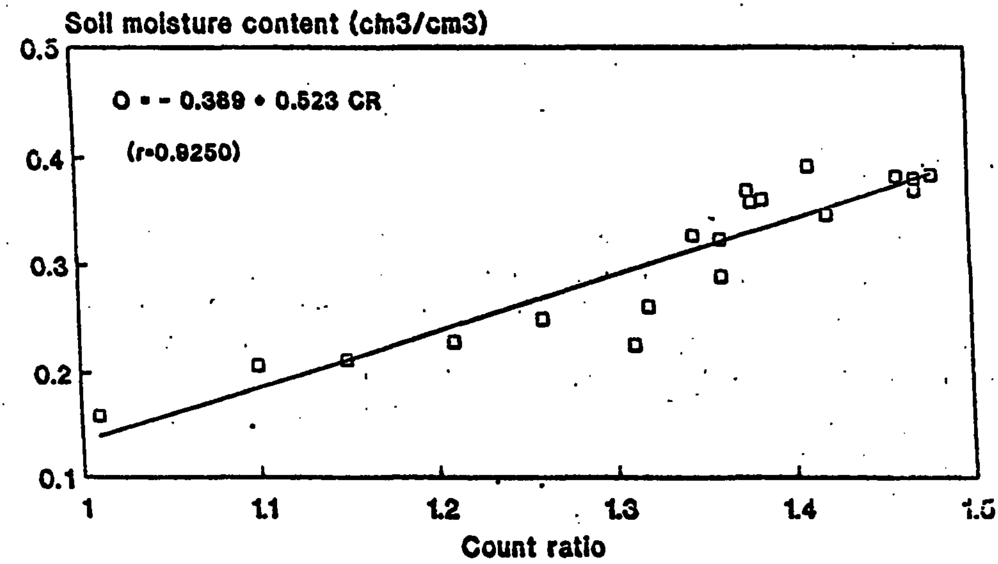

Fig. 4 Field calibration of neutron moisture meter for the sub surface layer, 10 – 160 cm

indicate that during wet periods, the count ratio may not be influenced by the location of the access tubes. But on dry days in general, distances 1.2 m to 1.8 m (4 to 6 ft.) from the tree appears to give the most reliable information with increasing accuracy at lower depths. No significant difference was seen in relation to the direction of the location of access tubes (Table 1).

Table 1. *Co-efficient of variation (%) different at depths and distances of access tubes*

Depth (cm)	Distance (cm)	
	120	180
10	30.6	28.6
20	66.4	56.3
30	49.2	45.3
40	40.7	33.1
90	12.1	15.3

Soil moisture status

Fig. 5 illustrates the available water storage capacity (AWSC) of the experimental area over a period of 12 months, which has an upper limit of 235.5 mm (field capacity) and a lower limit of 131.3 mm thus yielding an AWSC of 104.2 mm. Fig. 6 illustrates the available soil water in relation to the total rainfall for a 90 cm profile, which is generally the rooting depth of immature rubber, over a period of 12 months. A clear relationship exists between available soil water and total rainfall during this period.

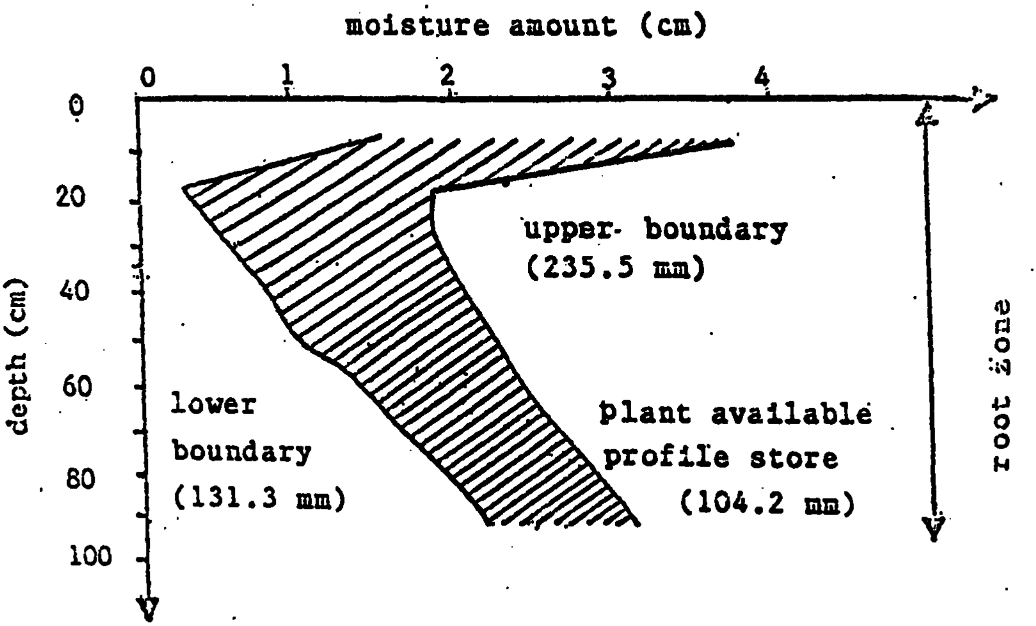

Fig. 5 The available water storage capacity

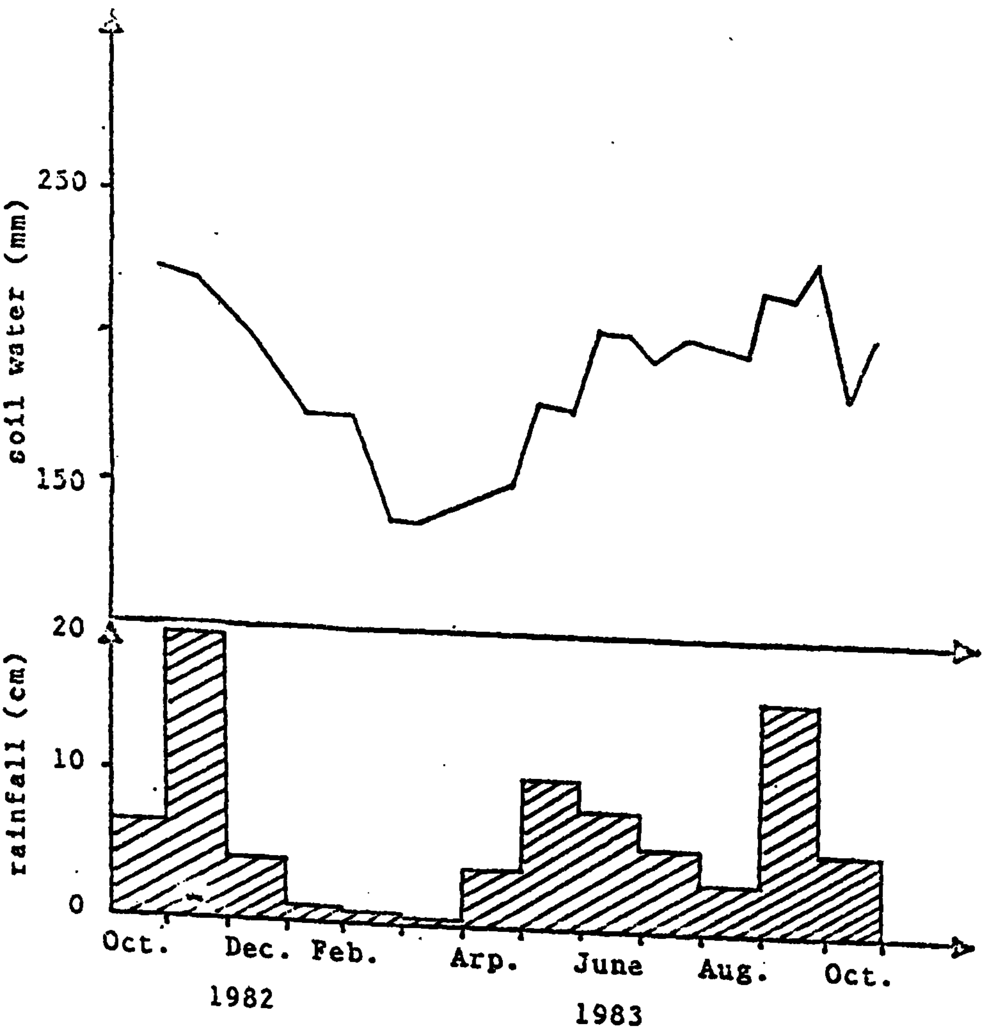

Fig. 6 Available soil water in relation to rainfall

DISCUSSION

In studies on soil–plant–water relations the Neutron Meter is used extensively to monitor soil water balance in the root zone whilst plant physiological and micrometeorological measurements are maintained on the above ground parts of the system. This study clearly establishes the effectiveness of these measurements in immature *Hevea* plantations. It had been possible to establish fairly reliable calibrationcurves for the neutron probe for the surface, 0–10 cm and subsurface soil 10–160 cm, possibly due to the absence of soil horizons with contrasting physical properties within the experimental area. This calibration would in any case be sufficient for comparison of agronomic treatment effects within the experimental site.

It appears that during dry period, distances varying from 0–1.2 m from the trunk of the tree are suitable for assessing the water content of the soil profile. This is in line with the previous reports based on the use of radiotracers that root activity in immature plantations is more towards the tree trunk than away from it (Liu Chong Qun,1984). In this study, it is possible that on wet days when the soil is saturated with water, daily changes due to transpiration losses may not have caused much fluctuation in the soil water content. But on dry days, the process of depletion and recharging from the moist layers may be continuous in the profile close to the trunk.

The available soil water storage capacity of 104.2 mm with the upper and lower limits of 235.5 and 131.3 mm, respectively, is likely to be the amount of water that is available to the plants, both rubber and covers over a period of 12 months. Clearly these upper and lower limits are somewhat arbitrary, yet in practical terms it has been possible to obtain a useful estimate of the profile water store and the available water storage capacity for *Boralu* type soils receiving a total rainfall of 2800 mm. This is further elaborated by the data on available soil water in relation to precipitation where a clear relationship exists between these two variables. It is evident that even during the most dry periods in January, February and March the available soil water has been in the region of 140 to 175 mm, with the lowest value of 140 mm in February. Total precipitation in the preceding 3 months i.e. in October, November and December of the previous year had been around 1000 mm. These results therefore seem to suggest that if there had been approximately 1000 mm of rain during the north east monsoon in the previous year there will be an adequate amount of water in the soil during the dry periods of January to April in the following year.

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