
CHARACTERISTICS OF AN ILL-DRAINED RICE SOIL PROFILE IN BOMBUWELA

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INTRODUCTION

IN a survey of the rice soils of Hewagam Korale situated in the flood plain of the Kelani Ganga it was observed that the imperfectly drained Panagoda series was predominant. (4) Further south in the Kalutara District very poor drainage has resulted in large tracts of ill-drained humic rice soils.

The soils of the Rice Research Station, Bombuwela, afford a typical example of these soils. There are, in addition to these poorly drained humic soils, sandy tracts in fields adjacent to the highland.

This area receives an annual rainfall of 100-125 inches, the greater portion of which falls from May to September and from November to December. The average yields on these soils are about 20 bushels per acre. Vermatt (6) referring to the South-Western low country wet zone of Ceylon states that "the predominant limiting factor in paddy production in this part of Ceylon is the prevalence of imperfect drainage or even the lack of any drainage,".

Imperfect sub-soil drainage is invariably caused by the topography or by discontinuities in the soil profile. The accumulation of toxic substances in the soil as a result of inadequate drainage is largely responsible for the initial set back in growth and for the physiological maladies like bronzing and root-rot.

MATERIALS AND METHODS

Description of the Soils. The rice soils of Bombuwela are of locally derived alluvium, deposited over the swampy floor of the valley. In depth they vary from several feet in the lower aspects to one foot or less in the higher regions of the slope. These soils are derived from the strongly weathered acid lateritic material (pH 4.9), rich in iron, low in bases.

The fields are level to gently sloping, with a flat to concave relief. Internal drainage is impeded. The very poor permeability of the sub-soil contributes to the poor internal drainage and the high water table during the greater part of the year.

A striking feature of these soils is their dark brown to black top soils with surface deposits of fine clay. The average organic matter content in the furrow horizon ranges from 5 to 10 per cent. In areas of very poor drainage where the top soil assumes a spongy texture the organic matter content may be as high as 15 per cent.

Below this is a relatively hard and compacted horizon. It varies from 4 to 10 inches in thickness, and sometimes contains more organic matter than the surface horizon. In many respects this region resembles a plow-sole.

Further down the profile at about 15 inches is a horizon of sandy clay which is distinctly lighter in colour due to its lower organic matter.

Below 25-30 inches is the heavy grayish white kaolinitic clay. This layer of very sticky and plastic clay is mainly responsible for the impeded vertical drainage. A typical profile has the following characteristics :—

0-7" Dark brown, 7.5 YR 4/2 clay (very humic) ; no mottles ; abundant organic matter ; pH 6.2.

7-12" Very dark brown, 10 YR 2/2, clay ; compact ; weak, medium angular blocky structure, sticky when wet occasionally a few faint yellow brown mottles ; pH 5.2.

12-30" Gray brown, 10 YR 5/2, sandy clay ; clay fraction decreases, and coarse sand fraction increases with depth ; no mottles ; pH 5.7.

30-36" Light gray, 2.5 Y 7/2, Kaolintic clay ; very sticky and plastic ; no mottles ; pH 5.3.

The horizons were differentiated on the basis of their colour, texture, and degree of compactness. Munsell colour notations described are for the dry soil. Results of the chemical analysis of soil samples collected from the various horizons of a typical profile are set out in Table I.

A variation of this typical profile is found in some of the very boggy areas where organic matter accumulates at a depth of about 16 inches. This may probably be due to the existence of a buried "A"

horizon owing to the cumulative origin of the soil or due to a modification of the horizon corresponding to the plow-sole. The characteristics of such a profile are as follows :—

0-7 in. Dark gray, 10 YR 4/1 clay (humic) ; no mottles ; abundant organic matter ; pH 5.9.

7-16 in. Very dark gray brown, 10 YR 3/2, clay ; compact ; no mottles ; weak, medium, angular blocky structure ; rich in organic matter ; pH 5.3.

16-31 in. Black, 2.5 Y 2/0, clay ; very compact and hard ; moderate ; medium, angular blocky structure ; sticky when wet ; abundant organic matter (presence of decaying plant material) ; no mottles ; pH 6.0.

31-39 in. Gray brown, 10 YR 5/2, sandy loam no mottles ; pH 6.1.

39-70 in. Gray 10 YR 6/1, Kaolinitic clay ; very sticky and plastic no mottles, hard when dry. Results of the Chemical analysis are shown in Table I.

Analytical Procedure. The pH and ferrous iron content were determined on the fresh soil from the field. The other determinations were done on air dried soil, passed through a 2 mm sieve. pH values were obtained using a glass electrode with a soil/water ratio of 1 : 1.

Nitrogen was determined by the Kjeldahl method. Available phosphorous was extracted according to Truog (5) and estimated by the molybdenum blue method. Exchangeable potassium was extracted with normal ammonium acetate solution and determined on the flame photometer.

The organic matter content was determined by the method of Walkley and Black (7).

Total iron, manganese and potassium were extracted with constant boiling hydrochloric acid (Hall's Method) (3). Iron was determined using o-phenanthroline according to Fortune and Mellon (1) and manganese by the periodate method, following Willard and Greathouse (8) (2).

Ferrous iron was extracted with Morgan's solution and determined using o-phenanthroline after addition of hydroxylamine. It was assumed that iron extracted by Morgan's reagent from fresh soil samples was mainly in the ferrous condition.

DISCUSSION OF RESULTS

THE water table has a marked influence on the profile characteristics. The high water-table and the consequent lack of aeration retard the biochemical process that effect decomposition of buried plants and plant residues.

The prevailing anerobic conditions restrict the oxidative processes of the micro-organisms. The result is the accumulation of organic matter.

The surface horizons are in a highly reduced state. Reddish brown rusty mottles of iron oxide frequently seen along the root channels and cracks in the well drained rice soils, are absent or are only occasionally present. Measurements of the oxidation reduction potentials have confirmed this view.

An interesting feature of these soils is that they are never very acid in spite of their very high organic matter content and the acidic and base deficient properties of the parent material. Measurements of pH of the fresh soil from the furrow slice gives values between 5.8 and 6.6. In the region of the plow-sole the soils tend to be more acid.

The soils are well supplied with nitrogen and fairly well supplied with phosphorous. The potassium content is however low.

The distribution of iron in the profile does not indicate any accumulation below the plow-sole as in the case of a well drained soil. The non-receding water table probably minimises the eluviation of iron, which is being constantly added to the surface from the adjacent ferruginous laterite highland. The content of F_2O_3 in the surface horizons usually vary between 4 and 7 percent. However in the basin shaped depressions (of relatively poorer drainage) the F_2O_3 content may be as high as 12 percent.

The distribution of manganese in the profile indicates a tendency for accumulation with depth. The manganese brought into solution after inundation is deposited in the relatively more oxidised regions at the lower depths and remain undisturbed, by subsequent plowing operations. The manganese content in these soils is generally low.

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Table I.—Soil Analysis of a Typical Profile

Depth	Texture		pH under field conditions	pH when dry	% organic matter	% Total N	Available P in ppm.	Exch. K. in mg. ² 100g soil	% Total Iron as Fe ₂ O ₃	% Total Mn as Mn ₂ O ₄	Ferrous Fe. in ppm.	% Total K.
Profile 1	0-7" clay	..	.. 6.2 ..	5.4 ..	12.07 ..	0.32 ..	68 ..	0.08 ..	4.30 ..	0.00078 ..	1,590 ..	0.068
	7-12" compact clay		.. 5.2 ..	5.2 ..	4.89 ..	0.28 ..	28 ..	0.02 ..	3.72 ..	0.00013 ..	718 ..	0.078
	12-30 Sandy clay	..	.. 5.7 ..	5.3 ..	1.38 ..	0.06 ..	40 ..	0.02 ..	3.50 ..	0.00056 ..	42 ..	0.049
	30-36 Kaolinitic clay		.. 5.3 ..	4.5 ..	1.90 ..	0.08 ..	148 ..	0.25 ..	3.44 ..	0.00078 ..	714 ..	0.130
Soil Analysis of profile from very boggy area												
Profile 2	0- 7" clay	..	.. 6.0 ..	5.1 ..	14.83 ..	0.66 ..	25 ..	0.21 ..	6.26 ..	0.017 ..	3,990 ..	0.156
	7-16" compact clay		.. 5.3 ..	5.0 ..	4.42 ..	0.59 ..	35 ..	0.10 ..	7.45 ..	0.018 ..	2,758 ..	0.136
	16-31" clay with large black particles of deorganic matter		.. 6.0 ..	4.9 ..	8.49 ..	0.54 ..	30 ..	0.16 ..	4.10 ..	0.020 ..	2,552 ..	0.150
	31-39" sandy loam	..	.. 6.1 ..	5.1 ..	1.38 ..	0.06 ..	28 ..	0.08 ..	4.71 ..	0.032 ..	178 ..	0.068
	39-70" Kaolinitic clay		.. 6.6 ..	5.0 ..	1.10 ..	0.06 ..	5 ..	0.35 ..	3.88 ..	0.029 ..	596 ..	0.166