Water table behaviour under irrigation in the rhodustalfs

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SUMMARY

Since rainfall and seepage from irrigation channels are thought to be the main cause for excess water in the well drained and imperfectly drained rhodustalfs (Red Brown Earths and their drainage associates) in the Dry Zone, an experiment was carried out at Maha Illuppallama during the dry season (March to August) 1980 to study their separate influences. Results indicate that it is seepage that contributes mainly to rising water tables in both land classes, although rainfall contributes to a shallower water table being maintained in the imperfectly drained slopes for a longer time. These findings may necessitate a reassessment of the location of irrigation main channels, or selective lining, and a more calculated cropping calendar.

INTRODUCTION

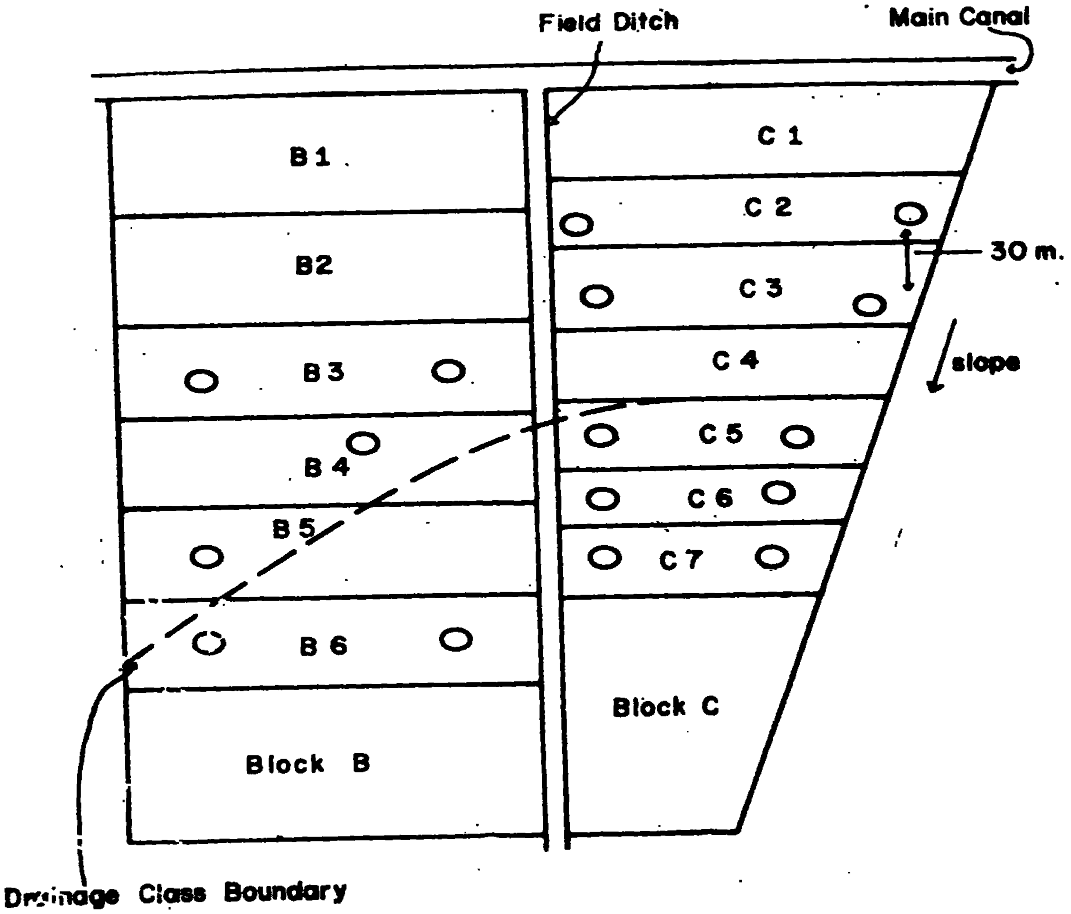
Water table rise in the soil profile of irrigated lands can be ordinarily traced to rainfall, seepage from surface bodies and/or from irrigation canal systems, over-irrigation, hydrostatic pressure from artesian aquifers, and/or a combination of any of these (7). Since it is difficult to isolate the influence of rainfall alone on water table rise from the other factors, the influence of it, alone with seepage can be studied by following judicious irrigation management practices (7). The distribution of the rainfall related to the fluctuations in water table levels would give an idea of its contribution towards the latter (7). A comparison of the ground water fluctuation with water in the canal systems would give information relating to seepage influence.

The major source causing the water table levels to rise in the profile must be known, so that proper protective measures can be taken. It is suspected that seepage, rainfall and over-irrigation combined together is the major cause for the rise in the levels of the water in the irrigated lands of Sri Lanka (6). An investigation of the influence of rainfall and seepage from the canal systems on water table fluctuation is therefore necessary to estimate their contribution towards the rise in levels.

MATERIALS AND METHODS

This investigation was carried out at the Agricultural Research Station, Maha Illuppallama, during the dry season (March-August) 1980, in the catchment 'C' water management project.

Augerhole positions in the Project



Block B = Graded terrace

Block C = Bench terrace

B 1 ········ B 6 and C 1 ············ C 7 = Terrace numbers

Water table behaviour was studied for the well and imperfectly drained drainage associates (popularly described as the reddish-brown earths) in the soil catena (5). Since water table levels above 120 cm are considered to be unsatisfactory for crop growth (7), the depth of installation of the open-cased augerholes (1) was restricted to 120 cm. Four pairs of augerholes were installed in a soil drainage class, down the slope. The distance between two successive augerholes, located down the slope was 30 m. Seepage influence from the canal system down the slope on water table levels can be studied from these augerholes. Of the four pairs installed in a soil class, one was located in the graded terraced block 'B' and the other three were in the bench terraced block 'C'. The differences in water table levels between the pairs in block 'B' and 'C' would give an idea on the influence of the types of land formation on water table levels.

The main canal in the project was filled daily with water to simulate profile hydrological conditions similar to that in irrigation schemes. Judicious water management practices were followed during irrigations to ensure that there has been no influence by over-irrigation on water table levels.

Water table levels and rainfall data were recorded daily. Weekly mean values for water levels were worked out from these data. Water table curves (Fig. 1, 2, 3& 4) were constructed with these values. Rainfall histograms for the corresponding weeks were superimposed on these curves.

RESULTS AND DISCUSSION

General Trend

Regardless of the soil drainage characteristics, the water table level fluctuations followed a definite pattern (3, 4) and (Fig. 1, 2, 3, 4). The levels began to rise with the onset of seasonal rains in late March. There was a steady rise in levels till mid-April, thereafter it fluctuated within a narrow range (following the path of precipitation) till mid-May. Once the rains ceased in mid-May, the levels first began to recede and then went into a steady state, but did not reach the original levels from where they began to rise. This steady state in the profile remained static till there was water in the canal system.

The water table level in the well drained soils, at the beginning of the season (late-March) was around 100 cm from the surface. With the progress in rains the levels steadily rose up to about 60-70 cm in mid April. Thereafter they fluctuated in that range till early May. In mid-May the levels began to recede and maintained a steady level at around 80 cm during the third week of May. However, they did not reach their original level (100 cm). The variation in behaviour of the curve in Figure 4 is due to the fact that the lower part of this terrace was imperfectly drained.

In the imperfectly drained soils the curves followed a similar pattern like the well drained soils, but the levels were different. At the beginning of the season the level was around 60 cm, but rose steadily to 20-30 cm in mid-April. Thereafter, it fluctuated in that range till late-May. In early-June the level began to recede and reached a steady state (60-70 cm) like in the well drained soils. However, the steady state level was equal to the original levels unlike in the well drained soils. A deviation in the behaviour of the curve in Figure 2 and its levels (relatively deeper levels) may be an influence of the type of land formation. Block 'B' in the project was developed into graded terraces and Block 'C' into bench terraces. The latter type affords more opportunity for the intake of water with less run-off compared to the two way sloping former system. Thus the water table levels in the graded terraces (B) were always deeper (5-10 cm) than that in the bench terraced area.

Soil drainage class — Water table levels — Precipitation

A steady rise in water table levels till mid-April was observed with precipitation, regardless of the soil drainage characteristics. However, the rate of rise was different, it was more in the well drained soils (11-13 cm/week) than in the imperfectly drained soils (6-7 cm/week). Commencing from mid-April the levels were fluctuating within narrow range of 12-15 cm and 7-10 cm respectively for the well drained and imperfectly drained soils till late May. Thus it appears that the fluctuation of levels with precipitation is more rapid in the former soils than in the latter. Though the rate of increase was more in the well drained soils, the levels never reached the same level as in the imperfectly drained soils with the accumulating precipitation. This may be the effect of the hydraulic gradient down the slope.

Soil drainage class — Water table levels — Seepage

The water table levels during the dry season in the well drained Red Brown Earths in the catchment were more than two metres below the surface, whereas they were in the region of two metres in the imperfectly drained soils (6). The curves constructed for the catchment after simulation of irrigated conditions, show that water begins to appear at a depth of about a metre in the former soils and 56-60 cm in the latter. Thus it appears that the major source of contribution towards excess water condition in the profile is through seepage from canal systems. The contribution is more in the well drained soils than in the imperfectly drained soils. The deviation from the normal behaviour of the curve in Fig 3 for the imperfectly drained soils may be an upwelling effect in that terrace.

Highest water table levels — Periods of saturation — Soil drainage class

The highest levels were in the region of 60 and 40 cm in the well drained and imperfectly drained soils respectively. The water levels fluctuated in these regions for about a month in the former and more than two months in the latter. The carry-over effect of precipitation was more in the imperfectly drained soils, where it took about four weeks to recede to its original levels, but this happened in one week in the well drained soils.

Water table fluctuations follow a definite pattern with precipitation and seepage regardless of the drainage characteristics. The seepage from the canal systems raises the water levels by more than a meter and about two meters in the imperfectly and well drained soils respectively. The dry season precipitation raised the levels by another 40 cm and 20 cm in the respective soil classes. Thus it appears the major source of excess water in the profile is through seepage from canal systems, but the damaging effect on upland crops is caused by the precipitation influence on the soil profile water. However, long-term records of precipitation should be related to long-term hydrography of water table levels to arrive at any decisions for the improvement of the profile conditions.

To take full advantage of the dry season rains for cultivation and to avoid the risk of shallow saturated profile conditions, it is suggested that the imperfectly drained soils be cultivated to rice, and well drained soils to upland crops. If upland crops are to be grown in the former soils, planting should be delayed till May.

In System H of the Mahaweli Diversion Project where more than 40 percent of the total extent (76,000 ac) is proposed for the cultivation of upland crops, the question arises whether this targetted acreage can be achieved, since the profile hydrological conditions in some locations may be a limiting factor for the cultivation of upland crops. Further, a continuous saturation of the profiles in the long run can create saline conditions. The water seeping down into the profile is a loss as far as the system is concerned. In the circumstances, it may be necessary to re-assess the location of main canals and/or resort to selective lining of these channels in System H.

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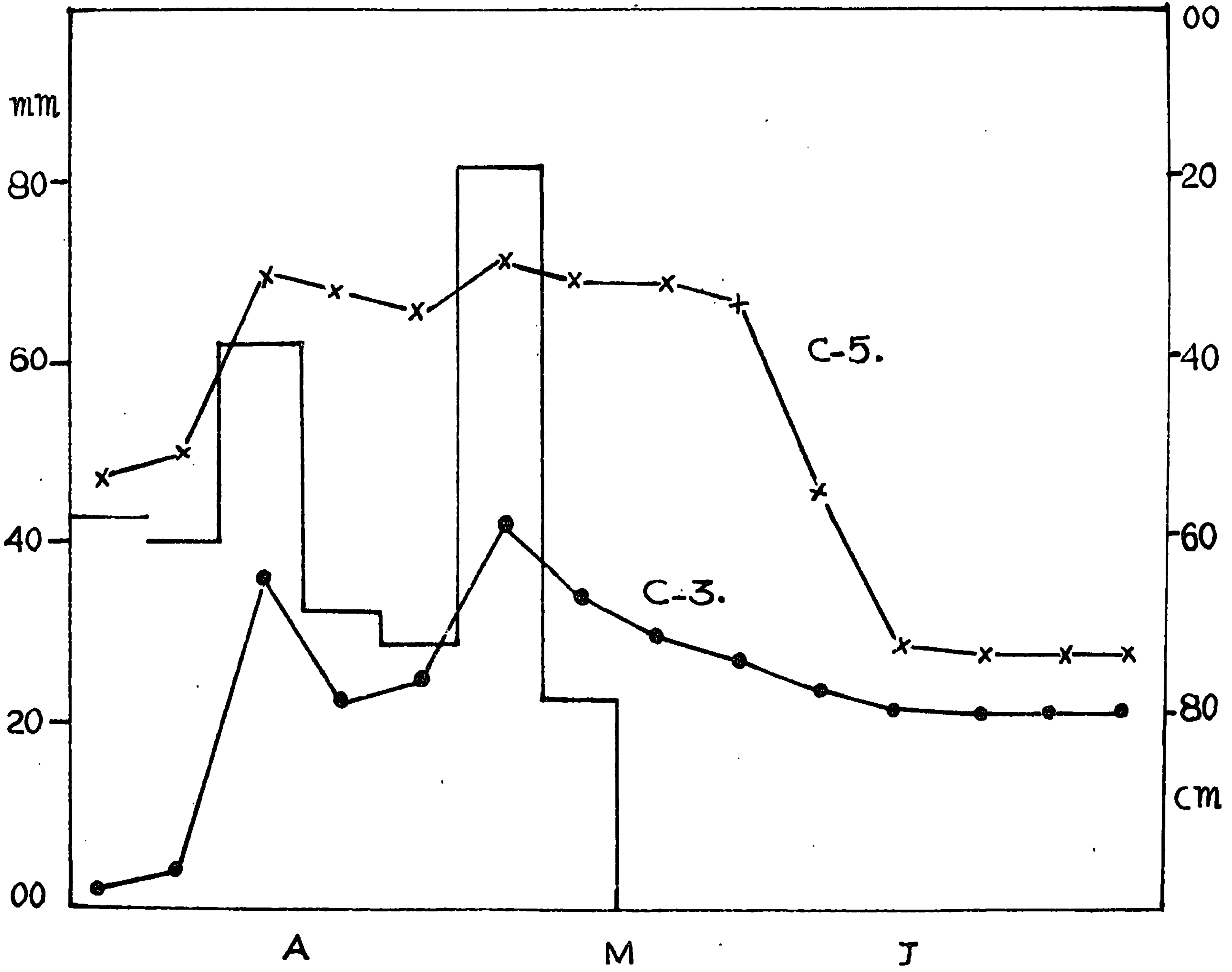

Fig. 1. Water table fluctuations (cm) with rainfall (mm)

x — x Imperfectly drained soils.
• — • Well drained soils.
A = April M = May J = June.

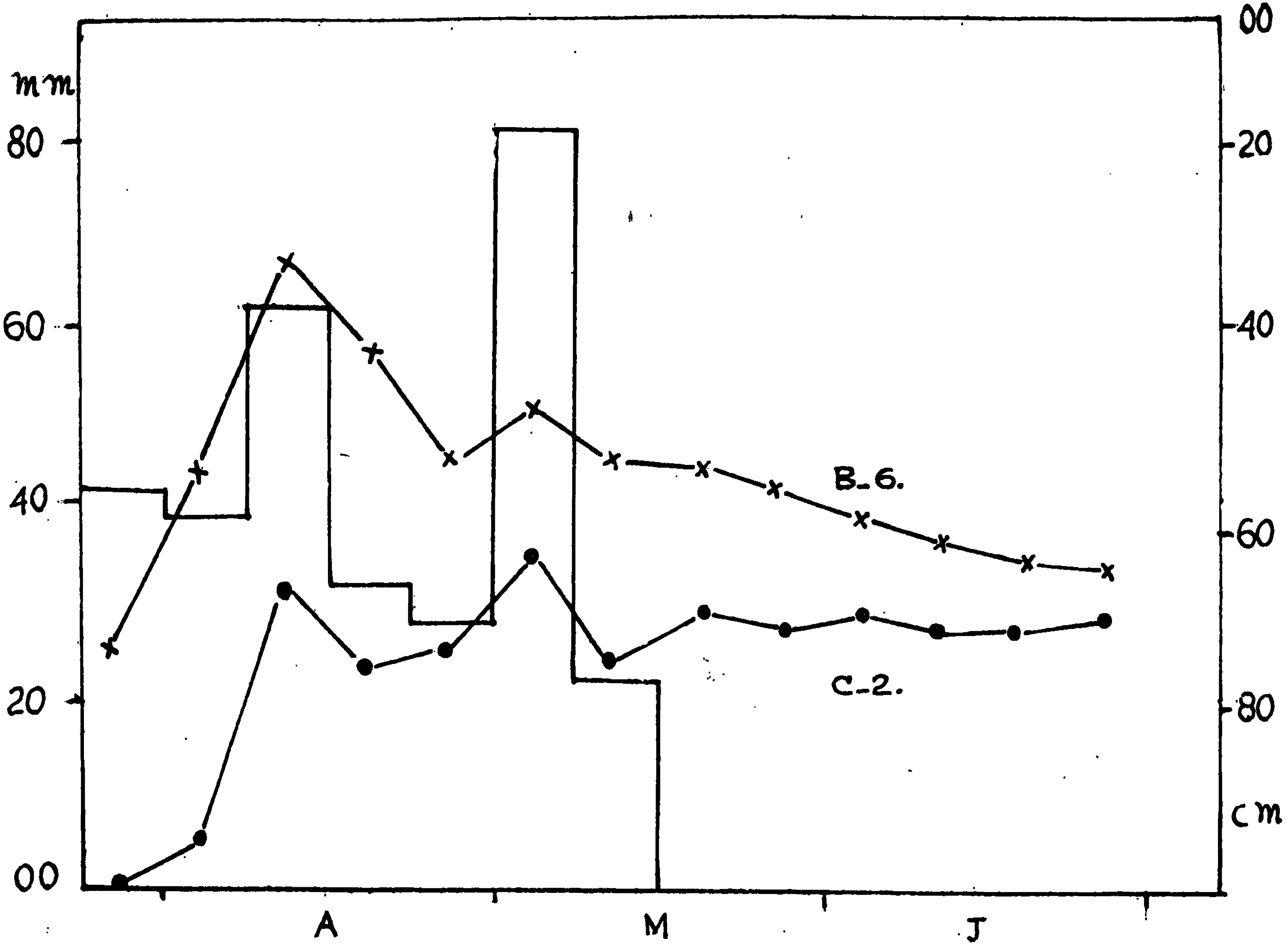

Fig. 2. Water table fluctuations (cm) with rainfall (mm).

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• — • Well drained soils.
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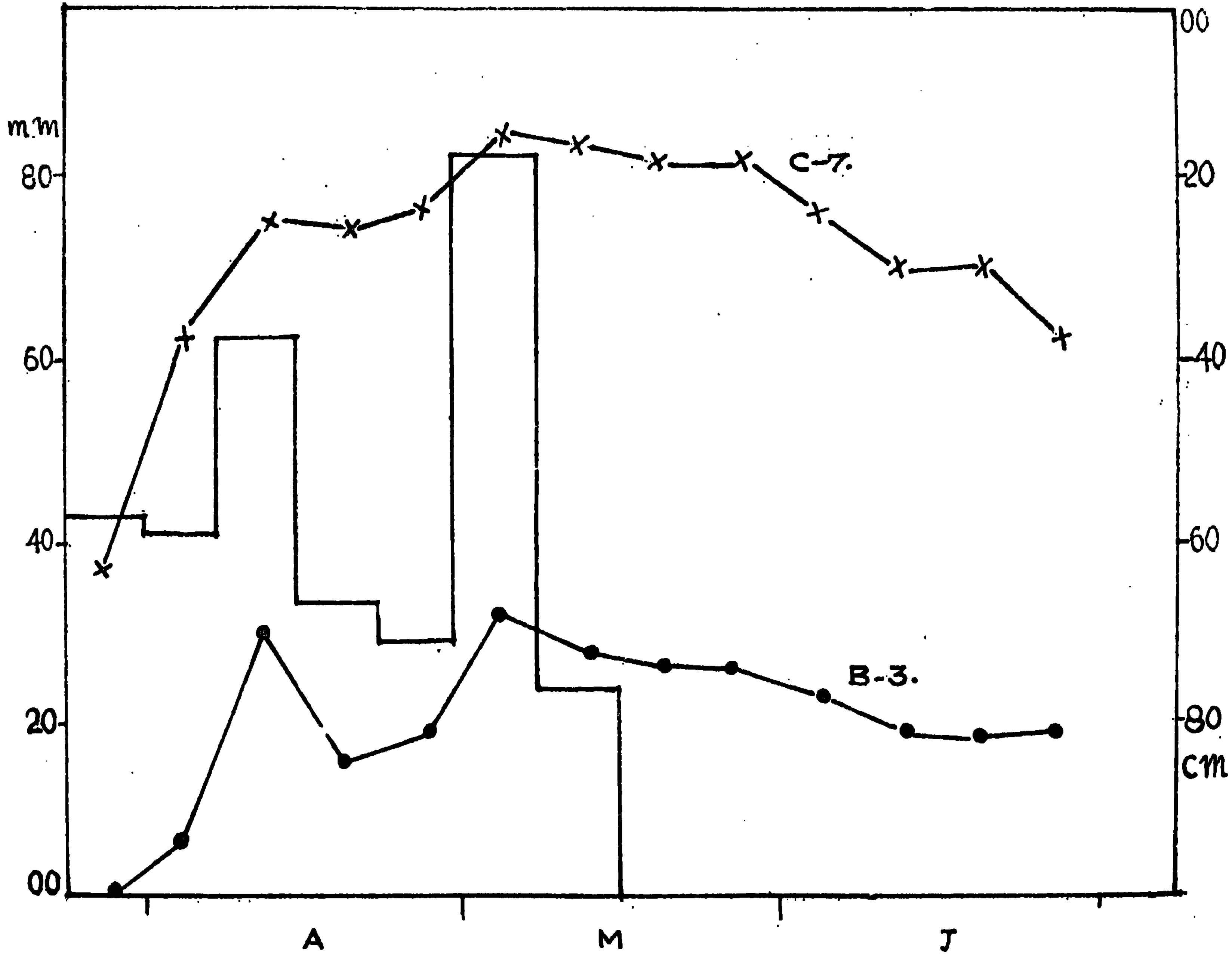

Fig. 3. Water table fluctuations (cm) with rainfall (mm).

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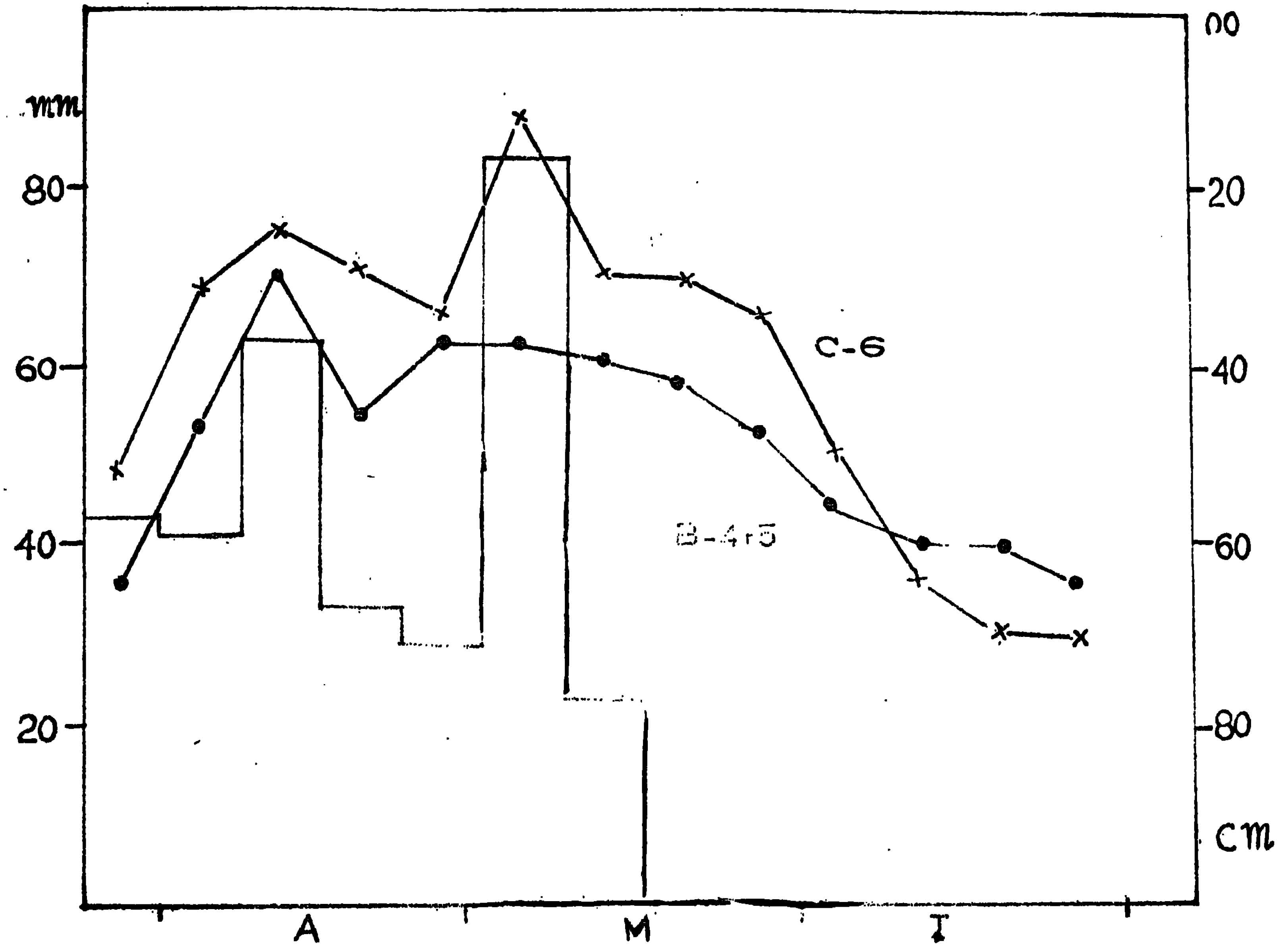

Fig. 4. Water table fluctuations (cm) with rainfall (mm).

x—x Imperfectly drained soils
•—• Well drained soils
A = April M = May J = June