ROTHAMSTED RESEARCH

The Soil at Rothamsted

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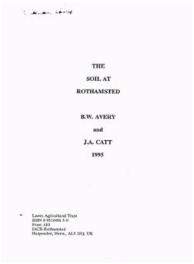

The Soil-map Units

Rothamsted Research

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estimated as 91 mm, some 44 mm less than AP, so that the crop is unlikely to suffer from drought and Yates (1969) concluded from a review of earlier investigations that wheat yields on Broadbalk were generally larger in dry years.

The deep, nearly stone-free silty soils of the Hook and Hamble series have larger available-water capacities than the Batcombe and Carstens soils and are predictably less droughty on this basis, though an experiment in 1976 on the Hook soil of Little Knott field (Fig. 1) showed that excluding rain from a spring barley crop for 4, 6 or 8 weeks in the main part of its growing season (April 28 onwards) using a mobile shelter decreased grain yield by 17, 29 and 41 per cent, respectively (Woodhead 1977). It is possible, however, that subsurface compaction at this site may have reduced the effective AP by limiting root development.

Of the remaining soils, the most droughty are those in Flint, Scout and Osier Fields that have loose gravelly subsurface horizons of varying thickness, as in profiles 16, 38 and 39. Grass in these areas was severely 'burnt' during the dry summers of 1989 and 1990, even in places where the winter water table is now high. The effective available-water capacity of the shallow chalky soils of the Upton series occurring in parts of White Horse and Drapers Fields is difficult to assess because the shattered Chalk substrate is penetrable by roots to varying depths, but is evidently larger than might be expected because the Chalk itself, unlike other consolidated rocks, is porous and holds considerable amounts of water extractable by plants (Burnham and Mutter 1993).

The Soil-Map Units

Typical Batcombe (139 ha)

This unit, occupying 46 per cent of the mapped area, consists mostly of Batcombe series with a flinty silty clay loam (U.S. silt loam) topsoil containing 18-27 per cent clay and strong brown to yellowish red clay with varicoloured mottling at less than 80 cm depth. The main variations, which can recur laterally within a few metres, are in depth to clay, degree of subsoil gleying and stoniness. In much of the old arable land, including Broadbalk (profiles 20 and 21), the clay is encountered immediately below the topsoil, the clay content of which may locally exceed the 27 per cent limit; elsewhere, as in most of High Field (profiles 2 and 13), a brown friable subsurface horizon similar in texture to the topsoil overlies clay at greater depths, and in variants marginal to the Hook series (profiles 1 and 22) passes downwards into mottled silty clay with few stones. The most gleyed profiles have red, brown and grey mottles within 60 cm depth, the greyest colours occurring on structural (ped) faces and around stones; in the least gleyed, which grade into Carstens soils in places where the underlying Chalk is relatively close to the surface, red mottles and paler brown ped faces are still evident within the same depth, but grey inclusions are rare or absent.

On the sloping land in Black Horse and Bylands fields (profile 34), both surface and subsurface horizons are generally more stony than elsewhere; the boundary between the superficial loamy layer and the clay subsoil tongues downwards to more than 80 cm in places, and the topsoil locally contains enough sand (clay loam rather than silty clay loam) for the soil as a whole to qualify as Hornbeam series (Table 2) rather than Batcombe.

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Heavy Batcombe (20 ha)

These soils also conform nearly everywhere to the Batcombe series but the topsoils are heavier, generally containing between 27 and 35 per cent clay, and the characteristically mottled Clay-with-flints subsoil starts at or a little below plough depth. In the main areas of occurrence on more or less eroded upper valley-side slopes in Barnfield (profiles 24 and 26), Agdell, Delharding and Claycroft, they grade into Carstens or Winchester soils as the Chalk approaches the surface. Smaller and less well defined patches, each with some topsoil containing 30 per cent or more clay, occupy nearly level plateau sites in Broadbalk (profile 19), Hoos, Little Hoos, Long Hoos and Great Harpenden fields. The patch in the south-west corner of Broadbalk is clearly revealed on a map of isodynes (lines of equal resistance as measured by drawbar pull) constructed by Haines and Keen (1925) from dynamometer readings, which they correlated with clay content (Avery and Bullock 1969).

Batcombe-Carstens (47 ha)

In the nearly level northern part of the farm mapped as Batcombe-Carstens, Batcombe soils with 18-27 per cent clay in the surface horizon are estimated to underlie at least 60 per cent of the area, but the subsoils are more variable than in the Typical Batcombe unit to the south. Thus around 27 per cent of the borings showed few or no mottles within 60 cm, so qualifying as Carstens or related well drained series, and 38 per cent revealed layers or patches of brightly coloured, more or less mottled sandy clay or sandy clay loam at varying depths below 30 cm. In a few places, too, particularly in Sawyers Field (profile 3), the loamy topsoil contains more than 20 per cent sand and so qualifies as clay loam rather than silty clay loam. These somewhat sandier soils, estimated to comprise no more than 20 per cent of the unit, may meet the requirements of the Sheldwich (well drained fine loamy), Marlow (well drained fine loamy over clayey) or Hornbeam (moderately well drained fine loamy over clayey) series, depending on subsoil texture and degree of gleying. Very small areas of Hook or Hamble soil (Table 2) with nearly stone-free silty subsurface horizons are also included.

Typical Carstens (7.5 ha)

The dominant component of this unit, the largest delineation of which extends from the western side of Great Knott into Knott Wood (profile 40), is well drained Carstens soil with a flinty silty clay loam (U.S. silt loam) topsoil containing 18-27 per cent clay and a yellowish red flinty clay subsoil overlying Chalk at depths greater than 80 cm. Similar soils of the Porton series (Table 2) with Chalk at less than 80 cm occur as sporadic inclusions, notably in Furze Field. Small areas of heavier Carstens or Batcombe soil are also included, the latter in places where the Clay-with-flints is thicker than about 1.5 m.

Carstens-Winchester (6.7 ha)

In a discontinuous belt of sloping land extending southwards from Great Knott (Fig. 1), and in a small part of White Horse Field, similar but generally heavier Carstens soils with Chalk at moderate depths occur in association with still heavier Winchester soils (profiles 5 and 30). As now defined, these have strong brown to yellowish red, unmottled flinty clay subsoils (Clay-with-flints *sensu stricto*) overlying more or less

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fragmented Chalk within 80 cm depth and no loamy surface horizon more than 15 cm thick. Small inclusions of heavy Batcombe with a mottled clay subsoil also occur where the undulating boundary between Clay-with-flints and Chalk descends locally to greater depths.

Hook (11 ha)

The soils of this unit, occurring in association with Batcombe in level or slightly depressed plateau sites, are developed in relatively stone-free silty drift (brickearth) which is composed largely of loess and overlies Clay-with-flints at depths greater than 80 cm. The dominant component, represented by profiles 32, 33 and 41 in Little Knott Field, has a brown silty clay loam to silty clay subsoil with paler coloured mottling at 40-80 cm depth. It is classed as a variant of the fine silty Hook series, intergrading to Batcombe, which is slightly more stony and contains rather more clay than typical Hook soils in Devensian (last glaciation) brickearth (e.g. Hodgson 1967). The largest delineation, in Whittlocks Field, also includes a small area of well drained (unmottled) but otherwise similar Hamble soil (profile 31).

Charity-Notley (18 ha)

Soils of the Charity series in flinty silty drift have flinty silt loam to silty clay loam topsoils, normally containing less than 27 per cent clay, and brown slightly to very flinty subsoils that become finer in texture with depth (profiles 12, 28 and 36). In the Charity-Notley unit, located in minor dry valleys heading on the plateau, they grade into superficially similar Notley soils (profile 4), the upper horizons of which are evidently in recent colluvium (Avery 1980). Charity soils and associated fine silty over clayey variants (profile 7) predominate in the valley extending through Knott Wood down into Stubbings and Drapers fields (Fig. 1). Here the non-calcareous subsoil horizons overlie chalky drift at varying depths. At higher levels they are generally underlain by Clay-with-flints and are in places less well drained, with varicoloured mottling below 40 cm depth, as in profiles 23 and 27 sampled in the lowest parts of Broadbalk and Barnfield respectively. These soils are identified as moderately well drained variants of the Notley series. The base of the colluvium is marked in both profiles by a layer that is more stony than the overlying horizons and rests in turn on a sequence of mottled silty horizons with few stones resembling those in Hook soils at comparable depths.

Charity-Hamble (20 ha)

In the Charity-Hamble unit mapped on footslopes in Meadow and parts of Black Horse, Scout and Osier fields, the dominant Charity soils grade locally into Hamble soil (profile 15) in which the upper horizons are only very slightly stony (< 5 per cent by volume) and more than half the upper 80 cm is stoneless (< 1 per cent). Both the stoniness and thickness of the brown silty subsurface horizons can vary considerably within a few metres, however, and reddish flinty clay is encountered within 80 cm in a few places, giving profiles that conform to the Carstens (profile 35) or Batcombe series.

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Maplestead (5.5 ha)

This unit, embracing parts of Flint, Scout and Osier fields, is distinguished by the common occurrence of very flinty (gravelly) subsurface horizons that resist penetration with an auger, so preventing examination of the profile to below 80 cm as required for positive identification of soil series. The upper horizons are generally also coarser in texture, mainly sandy silt loam, than in the adjacent Charity-Hamble unit. Coarse loamy Maplestead soils (profile 16) in which a subsurface gravelly layer overlies a brighter coloured, less stony and finer textured horizon within 80 cm are probably dominant, but flinty silty clay loams of the Charity series also occur, and variants in which gravelly material extends below 80 cm may conform to the fine silty over gravelly Rowton (profile 14) or the loamy-gravelly Bockmer series (Clayden & Hollis 1984), depending on the thickness and texture of overlying horizons.

Panholes (10 ha)

Soils with more or less flinty silty clay loam to clay topsoils and Chalk or chalky drift at moderate depths underlie the greater part of Knott Wood and much of Stubbings, Drapers, Webbs and White Horse fields, covering in all some six per cent of the estate, rather more than half of which is mapped as Panholes. The Panholes soils (profile 8) have brown, very slightly to moderately calcareous silty clay loam subsurface horizons overlying fragmented Chalk within 80 cm, and generally give place on lower slopes to essentially similar Coombe soils (profile 18) in which the substratum is compact chalky drift rather than Chalk *in situ*. The unit also includes small areas of Upton soils, where Chalk is closer to the surface and the brown subsoil is missing, and pockets of deeper, more or less completely decalcified soil of the Wold or related series (profiles 9 and 29), in which a clay-enriched Bt horizon has developed.

Upton (4.5 ha)

As shown on the map, shallow chalky soils of the Upton series predominate in parts of White Horse and Drapers fields. In earlier surveys (e.g. Avery 1964) they were included in the Icknield series, now restricted to very dark coloured (humic) rendzinas on Chalk as originally described by Kay (1934). The topsoils, normally of silty clay loam (U.S. silt loam to silty clay loam) texture, contain much finely divided chalk and are greyish brown to brown when moist but become paler in colour when dry. Fragmented chalk or extremely chalky unconsolidated material is encountered directly below the ploughed layer or within 30 cm depth.

Wallop Complex (3.5 ha)

In this unit, mapped in the southern part of Knott Wood and White Horse Field, more or less disturbed Chalk occurs nearly everywhere within 60 cm of the surface, but the thickness and morphology of the overlying horizons vary over short distances. As they incorporated vestigial or disturbed remains of Clay-with-flints, they are generally more flinty and finer in texture than in the Panholes-Coombe and Upton units. Although no single soil series is clearly dominant, Wallop soils (profile 6) with flinty clay topsoils and thin brown or reddish subsurface horizons of similar texture are extensive, grading on the one hand into shallower, less clayey and more calcareous Upton soils and on the other

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into Winchester soils, in which the clayey subsurface horizon extends to depths greater than 30 cm and contains little or no calcium carbonate.

Ver Complex (5.5 ha)

This unit, which was formerly well represented in Ver Field (profiles 37, 38 and 39), is now confined to the lower part of Flint Field, through which the stream runs, and the adjoining partly wooded area (Ver Spinney). As far as can be ascertained, the ground has never been cultivated and the surface is uneven, with former stream channels or closed depressions alternating with slightly higher terrace remnants. Although the soils vary morphologically in broad accordance with the micro-topography, they all have very dark coloured, very friable surface horizons with well developed granular (crumb) structure and a substratum of flint gravel with a sparse loamy matrix which becomes finer in texture at varying depths.

Three distinct variants were identified and mapped in the detailed survey of Scout Farm, as follows:

Soil G, represented by profile 38 (Tidmarsh series) is associated with the higher ground and shows little or no evidence of gleying in the upper 40 cm. The brown gravelly subsurface horizon becomes paler in colour with depth and tongues downwards into a more compact, clay-enriched Bt horizon with ochreous and greyish mottling related to former watertable levels.

Soil C is confined to low lying, seasonally wet, areas and is characterized by a surface layer of calcareous silty alluvium attributable to recent (Holocene) sedimentation. In profile 39, classed as a variant of the Binstead series (Hodgson 1967), the calcareous silty layer overlies non-calcareous loamy gravel at 25 cm depth and all the subsurface horizons are gleyed. In part of Ver Spinney the calcareous silty layer is 35 cm or more thick and the dark topsoil is also thicker and richer in organic matter, so that the profile as a whole qualifies as a calcareous humic-alluvial gley soil (Avery 1980).

Soil H, represented by profiles 17 and 37, also occupies low ground and has greyish silty upper horizons overlying gravel but is non-calcareous throughout. In profile 17 the 25-41 cm horizon is interpreted as a buried topsoil, presumably dating from a period before deforestation and cultivation of the adjoining upland slopes led to increased run-off and erosion, with consequent renewal of sedimentation in the river valley.

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