Report on a Soil Survey of the Boundary Bend Irrigation Settlement

By

J.K.M. Skene, Senior Chemist (Soil)*

October 1949

GENERAL FEATURES

Location

Boundary Bend irrigation settlement is situated in the parishes of Yungera and Nerrung, County of Tatchera. The settlement, 56 miles north-west of Swan Hill, lies on each side of the Murray Valley Highway and closely adjoins the Murray River.

An area of 1,192 acres has been covered by soil survey, but not all of this is under irrigation.

Horticultural Development

A few acres of citrus, vines and stone fruits have been grown under irrigation at Boundary Bend for nearly forty years, but it is only within the last eight years that any worthwhile horticultural expansion has taken place. The proximity of deep sand ridges to the Murray River attracted to the district several orchardists form Mildura and Coomealla who saw possibilities for citriculture. Their firs plantings were adjacent to the river, but subsequent extension has forced plantings back about three-quarters of a mile.

At present, there are ten blocks in the settlement, each carrying from 2 to 100 acres, and in all aggregating about 350 acres of citrus. Most of the growers have not yet completed their plantings, and it is estimated in the district that the citrus acreage will eventually reach about 500 acres in all.

Water is supplied by private pumping from the Murray River, and, except for about 17 acres, established trees are spray irrigated. All equipment is not yet installed on the younger groves, but spray systems of irrigation are contemplated for the major plantings.

Trees are unthrifty in certain situations. A fairly large number of young trees has been lost by frost damage in some of the relatively low-lying situations, but, in addition, older trees have declined on some lower slopes and in depressions between ridges.

Topography

The landscape is typical of areas where the Victorian mallee adjoins the Murray River. It has essentially an undulating topography formed by prominent sand-ridges with broad hollows between them.

In the eastern half of the surveyed area, the sand-hills dominate the landscape, particularly one bifurcated high ridge which protrudes into a bend of the Murray River and drops away on three sides to the flood plain of that river. Depressions occur within thin large area of sand-hills and several of these lead as narrow drainage lines to the river flats. Further to the west, the sand-ridges are smaller and areas of gentle slope are more extensive, while the natural drainage leads to extensive broad hollows enclosed within the ridge system. Centrally in the settlement, the Murray River is outing directly into the sand-ridges.

---

* Messrs. J. Berryman, Horticultural Research Officer, and H. H. Winnall, Field Officer, assisted with the field work.

Vegetation

Red gum (*E. camaldulensis*) and black box (*E. largiflorens*) remain on the flood-plain areas, but elsewhere the natural vegetation has been nearly wholly removed. However, some of the unplanted areas carry mallee re-growth with porcupine grass (*Triodis irritans*) and hop bush (*Dodonaea viscosa*).

There is evidence that the sand-ridges nearest the river originally carried Murray pine (*Callitris glauca*), belar (*Casuarina lepidophlois*) and mallee (*E. dumosa* and *oleosa*), while further inland the vegetation on the ridges was mainly small mallee (*E. oleosa*) and porcupine grass. Mallee and belar appear to have been the principal members in the depressions.

THE SOILS

General Characteristics

Apart from the river terrace soils which were not examined in detail and will not be considered further in this report, the soils belong to the zonal group of solonised brown soils (Prescott, 1944), commonly known as Mallee soils.

The surface soils vary from brown to red-brown in colour, but are remarkably constant in texture, being almost universally in the sand class. Subsoil textures are more variable and range from sands to sandy clays. However, about 60% of the area has soil types in which the soil profile as a whole is very light, being sand, sometimes with sandy loam, to beyond 6 feet from the surface.

The lime content is lower than is normal for Mallee soils. The lightest soils have little or no visible lime before 7 feet, but the relatively heavier soils on the lower slopes and in the broad depressions have up to light concentrations. Large accumulations of rubble limestone are not present anywhere in the area.

Description of the Soil Types

The principal soil types are Winkie sand and Murray sand; in addition, there are five soil types of lesser extent which have not been named, while several small areas are grouped as minor depressions soils. The distribution of the soil types is shown on a soil map of the settlement.

Winkie Sand

Marshall and Hooper (1936) first recorded Winkie sand at Berri and Cobdogla in South Australia where it occupies the mallee-spinifex (porcupine grass) sand-ridges. The profile is described as a loose red-brown to brown sand passing to a light brown sand; lime occurs in small about below 3 feet where the texture is sand or sandy loam to 5 feet. Later the type was found in similar situations by Hubble and Crocker (1941) at Redcliffs. However, here the surface is described as a pale brown rather than red-brown sand and there is considerable lime, sometimes as cemented pan or rubble in the profile below 27 inches; textures are sand or sandy loam in the lime rich horizons. Herriot and Johnston (1941) describe Winkie sand at Waikerie as a very deep sand, sometimes without sandy loam textures to a depth of 12 to 120 feet, and with only a trace of lime in the profile, although some exceptional profiles do contain lime pan and rubble. Northcote and Boehm (1949) have renamed soils mapped earlier as Winkie sand at Coomealla, Mallee sand, and state that this soil type has textural similarities to Winkie sand as mapped at Waikerie. However, their description of Mallee sand appears to make it a heavier soils below 4 feet. From the above, it is apparent that considerable variation from Marshall and Hooper's original description of Winkie sand at Berri and Cobdogla has been allowed elsewhere.

At Boundary Bend, Winkie soils, as is usual, occupy east-west ridges carrying small mallee and porcupine grass in the virgin state. The colour of the surface soil is probably best described as brown, although in comparison with some other brown soils in the area, it appears to have a characteristic yellowishness. This yellowish tinge persists throughout the soil profile. Soils which show evidence of some, although possibly slight, increase in texture before 6 ft have been mapped as normal Winkie Sand. Such soils contain very little visible lime and appear to approximate to Marshall and Hopper's original description.

Profile

0”
Brown loose sand
6” Diffuse junction
Light brown loose sand
36” Diffuse junction at variable depth
Light red-brown clayey sand or sandy loam
48”
Light brown or light reddish brown sand; very slight lime
84”
Light reddish brown sandy loam; slight lime
114”

Deep Phase – More common at Boundary Bend are Winkie type soils in which there is no visible lime and no perceptible alteration in the sand texture of the soil profile before 6 ft at least. Such soils have been separated as a “deep phase” and appear to conform to the Waikerie occurrences.

Profile

0”
Brown loose sand
6” Diffuse junction
Light brown sand
42” Diffuse junction
Light reddish brown sand
60”
Light brown sand
84”
Light brown sand; slight lime
114”

Murray sand – This type was first described at Renmark by Taylor and England (1929), but it has since been recorded in most of the horticultural settlements in Victoria, New South Wales and South Australia which adjoin the Murray River downstream from Swan Hill in Victoria (CSIR Bull. No. 42, 45, 56, 73, 86, 107, 123, 133 and 137).

Murray sand is found on the crests of sand-ridges carrying mallee, belar, and Murray pine, and is described in general terms as a red-brown or brown sand passing to lighter shades, and increasing slightly in texture below 3 ft but not to more than sandy loam; slight lime usually occurs below this depth. However, Murray sand has included a fairly wide range of soils, particularly in the earlier soil surveys, and recently Northcote and Boehm (loc. Cit.) at Coomealla have described two types in the Murray series and two in an allied Tiltao series, all of which have probably been mapped as Murray sand previously.

Phases within the Murray series have not been described elsewhere, but, as with the Winkie sand, a deep phase has been recorded at Boundary Bend to include situations in which sands persist without increase in texture and without visible lime to depths beyond 6 ft in the soil profile. Incidentally, the “normal” profile which is described below is far less widespread in this area than in the deep phase.

Profile

0”
Brown or reddish brown sand; slightly coherent.
36” Diffuse junction at variable depth
Light red-brown sandy loam
50” Variable depth
Light red-brown or light brown sandy loam; slight lime
72”

The inscription “shallow profile” on the map marks two marginal situations in which textures increase to sandy clay loam at about 5 ft.

Deep Phase Profile

0”
Brown or reddish brown sand; slight coherent
36” Diffuse junction at variable depth
Light reddish brown sand, sometimes very slightly heavier from about 72 inches
90”
Light brown sand’ slight lime
150”

Unnamed Soil Types – types A, B, and C have brown to red-brown light textured surfaces and are differentiated chiefly by the texture of their subsoils. Type D is a grey-brown sand surface type of certain depressions; while the surface of Type E tends towards greyish brown although otherwise this type is texturally not very different from Type B.

Type A – This type is situated on slopes below Murray sand, and apparently it carried similar vegetation in its virgin state.

Profile

0”
Reddish brown sand
12”
Light brown sand
36” Diffuse junction at variable depth
Red-brown sandy clay loam
60”
Mottled red-brown, brown, yellow sandy clay loam or sandy clay; slight lime.

In several situations, the sandy clay loam in the deep subsoil reverts to sandy loam or sand before 6 ft; these have been inscribed on the soil map “sandy loam deep subsoil” and “sand deep subsoil”, respectively.

Type B – This type is found mainly in the west of the settlement where the sand ridges are least extensive, and it occupies much of the relatively low-lying country between the rises. Where it adjoins Winkie sand, it extends to Type C at lower levels. The original vegetation was probably mallee and belar.

Profile

0”
Reddish brown sand; compact
18” Distinct junction
Red-brown sandy clay loam
30”
Brown sandy clay loam; slight lime
48”
Brown sandy clay loam or sandy loam; lime and slight rubble
72”

Type C – The largest expanses of Type C are in association with Type B in the west of the area. Here the type occupies the lowest situations in the topography as broad flat areas and enclosed hollows. Further eastward it is restricted to several drainage ways which lead to the flood plain of the Murray River. In the virgin state, Type C probably carried belar and mallee.

Profile

0” Red brown compact sandy loam or sand
14” Distinct junction
Red-brown or brown sandy clay. Sometimes light clay
27”
Brown sandy clay; light lime and rubble
42”
Brown sandy clay loam; light lime and rubble
72”

The two lowest horizons may be more or less mottled with red and yellow shades. Depressions in proximity to the river terrace soils may have grey clay in the seep subsoil below 4 ft. These situations are suitably described on the soil map.

Type D – The occurrence of Type D is closely linked with that of Winkie sand. It occupies enclosed depressions largely surrounded by that type and originally carried similar vegetation.

Profile

0”
Grey-brown loose sand
6”
Light greyish brown loose sand
27” Distinct junction but at very variable depth
Mottled red-brown and yellowish brown with slight light grey, sandy clay loam or sandy loam; hard and cemented when dry
36”
Reddish and yellowish brown sandy loam; light lime
48”
Similar, or sand; slight lime and rubble,
108”

Type E – This type occurs at intermediate levels in the topography. Most situations are on lower gentle slopes adjoining Winkie sand. Well grown mallee and some porcupine grass appear to have been the principal species on this type.

Profile

0”
Greyish brown sand
8”
Light greyish brown sand
21”
Reddish brown sandy clay loam
36”
Brown or yellowish brown sandy clay loam or sandy loam; slight lime
48”

Minor Depression Soils – A few small depressions within the larger sand-ridge areas have not been classified. They have been inscribed on the soil map with numbers 1 to 4 according to the soil profiles listed below.

Profile 1

0”
Dark greyish brown sand passing to dark brown sand.
54” Gradual lightening in colour
Light brown sand
72”

Profile 2

0”
Greyish brown sand or sandy loam
15”
Reddish brown sandy clay loam or sandy clay; slight lime
48”

Profile 3

0”
Reddish brown sand
27”
Light red-brown sandy clay loam
42”
Mottled red-brown, yellow, brown, sandy clay; slight lime
72”

Profile 4

0”
Grey-brown sandy loam
12”
Grey-brown light clay
27”
Grey-brown medium clay; light lime and rubble
42”

Extent of the Soil Types

The areas of the individual soil types are as follows:

Murray sand	73 acres
Murray sand deep phase	194 acres
Winkie sand	101 acres
Winkie sand deep phase	145 acres
Type A	62 acres
Type B	58 acres
Type C	130 acres
Type D	80 acres
Type E	48 acres
Minor depression soils	7 acres
River Terrace Soils	294 acres

There are 898 acres of Mallee soil types of which 575 acres comprise soil types considered suitable for citriculture. These are Murray sand (267 acres), Winkie sand (246 acres) and Type A (62 acres).

Private development of Winkie sand country beyond the limits of the surveyed area is unlikely because of pumping costs, and even some of the more remote areas of Winkie sand which have been included in the survey may not be considered for irrigation for the same reason. Having regard to this, the figures indicate that the nature of the soils will limit the probably expansion of citrus plantings to about 500 acres. Actually some of Type D has been planted, but trouble have developed here and future planting of this type is not recommended.

Salt Content of the Soils

Samples at 3-4 ft and 5-6 ft in the soil profile were taken from borings scattered over the area, and have been analysed for sodium chloride content.

Virgin mallee soils are inherently saline to a degree depending on the soil type and the situation in the topography. Generally, the light profile soils such as Winkie sand and Murray sand have low contents of sodium chloride. This is the case at Boundary Bend, where 42 from a total of 46 soil samples taken at the 5-6 ft depth in the profile from these soil types have sodium chloride contents of less than 0.050% (36 are below 0.025%). The salinity level of Type A is very similar, only occasional holes recording more than 0.050% of sodium chloride in the soil. That salt contents are generally low in the Murray and Winkie sand types to greater depths than 6 ft is shown by values of les than 0.050% found in all horizons of the soil profile to a depth of 12 ft at four separate locations. However, soil salinity should not be underrated in these soil types, since salt contents within the 0.050 – 0.100% range, which is a dangerous concentration in the soil for citrus, were recorded at the 5-6 ft level in four situations.

The inherent salinity of Type D is not high, the highest recording being 0.051% from a sample taken at 3-4 ft; but its low-lying situation adjoining the very permeable Winkie sand makes it susceptible tot he development of ground water under irrigation. Water close to the surface in such situations was observed during the course of the survey and this, even at a relatively low salt level in the soil, has contributed towards the death and poor condition of the trees on this soil type.

There is an erratic distribution of salt in Types B and E but most of these soils show an unsatisfactory salt status for irrigation citriculture; actually 15 out of 23 samples have sodium chloride contents exceeding 0.050% and 10 of these values are within the 0.100 – 0.200% range.

Type C which receives much of the drainage from the surrounding higher country can be regarded as the most inherently saline of the soil types. Many of its soils have more than 0.1% - and quite a few have more than 0.2% - of sodium chloride at 3-4 ft. The highest salt recording was in this soil types, viz., 0.32% at 5-6 ft.

SOILS IN RELATION TO CITRICULTURE

There is considerable practical experience of fruit growing on known Mallee soil types under irrigation which can be applied to the development of new areas. As the present growers at Boundary end are almost entirely interested only in citriculture, other uses of the soils will be considered briefly.

There is abundant evidence that the heavier Mallee soils and those which contain much lime are unsuitable soils for citrus. Types B, C and E are within this category and are not recommended for future plantings. They also have other disabilities, notably salt and frost hazards, the latter due to the relatively low-lying situations of these soil types. Having regard to the two hazards mentioned, these types should be suitable for vines and vegetables.

Only a small area of Types B, C and E have been planted to citrus at Boundary Bend. The principal planting has been in a depression line to Type C in allotment 3. This location is very badly drained and in places is very heavily salted. Citrus have failed entirely and it would be useless to persevere with citrus in this depression. Trees on the adjoining lower slopes of Murray sand may become affected unless the depression is adequately drained. This should not be difficult as the area has a natural outfall to the river; a shallow open drain should serve the purpose.

Experience has indicated that deep, lime free* sands are the most reliable of the mallee soils for growing citrus under irrigation; both Murray and Winkie sands are of this type at Boundary Bend. However, experience has also shown that these soils require careful handling for successful results, particularly in regard to manurial treatment and irrigation practices. Murray sand, and Winkie sand in particularly, are of relatively low deficiency and other nutritional disorders, such as “little leaf” caused by a deficiency of zinc. At Boundary Bend, many trees about 8 years old growing on Winkie sand are small and, in addition, show symptoms of chlorosis. Winkie sand and Murray sand absorb water extremely readily, and, if irrigated by the furrow system, installation of underground drains is essential prevent waterlogging in the lower slopes and in adjoining soil types. More efficient control of irrigation water is possible with spray irrigation and this system is now recognised as the only suitable method of applying water to the very light soil types if underground drainage is to be avoided. Fortunately the settlement will be watered almost entirely by this means, but there is already evidence of inadequate control of water in portion of allotment 2. Herriot and Johnston (1941) at Waikerie have estimated that from 2 to 3 inches of water are sufficient to raise the moisture content of Winkie sand to

* Visible lime absent from the first few feet of the profile; all mallee soils contain at least a trace of calcium carbonate in the deeper subsoil.

a depth of 4 ft from wilting point to its field capacity (certain other sand types require up to 4.7 ac in). From this it is evident that light, but possibly frequent, watering are called for, heavy applications will not extend the time between irrigations but may eventually cause a water-table. Whilst some control can be exercised from knowledge of the rating of the pump (45,000 gallons = 1 ac. In) taken in conjunction with the time of operation and the area to be irrigated, the best means of control is to examine the soil frequently for depth of penetration of water. In these light sandy soils, this may be done with a spade, but a soil auger (4 in post-hole digger type) is more useful in that it enables the deep subsoil to be examined very easily for the presence of free water.

Type D, although a light soil type, is not recommended for citriculture and, where planted, trees have failed almost entirely. The soil appears to be of low fertility while some damage has been due to frost. But its chief disability is in its liability to seepage troubles due to its proximity at lower levels to Winkie sand. Even with the most careful control of irrigation, the accumulation, of subsoil water in Type D depressions would be difficult to prevent, except where underground drainage is practicable. An attempt is being made to drain one badly affected area in allotment 2 where there is a suitable outfall to the river; however drainage of most situations does not appear to be feasible. Lucerne grown between the tree-rows should help in lowering the water table and so assist in improving affected areas.

The minor depression soils suffer from the same hazards as Type B but are small in area; profile 4, in addition, is a heavy soil and is not suitable for citrus.

REFERENCES

1. Herriott, R. I., and Johnston, E.J. (1941) – A Soil Survey of the Waikerie Irrigation Area, South Australia. Coun. Sci. Ind. Res. (Aust) Bull. 141.
2. Hubble, G.D., and Crocker, R.L., (1941) – A Soil Survey of the Red Cliffs Irrigation District, Victoria. Coun. Sci. Ind. Res. (Aust) Bull. 137.
3. Marshall, T.J. and Hooper P.D. (1935) – A Soil Survey of the Berri, Cobdogla, Kingston and Moorook Irrigation Areas, and the Lyrup Village District, South Australia. Coun. Sci. Ind. Res. (Aust) Bull. 86.
4. Northcote, K.H. and Boehm, E.W. (1949) – The Soils and Horticulture Potential of the Coomealla Irrigation Area. Coun. Sci. Ind. Res. (Aust) Soils and Land Use Series No. 1.
5. Prescott, J.K. and England, H.N. (1929) – A Soil Survey of Block E (Renmark) and Ral Ral (Chaffey) Irrigation Areas. Coun. Sci. Ind. Res. (Aust) Bull. 42.