CRC

Profitable soil management for orchards in the Goulburn Valley

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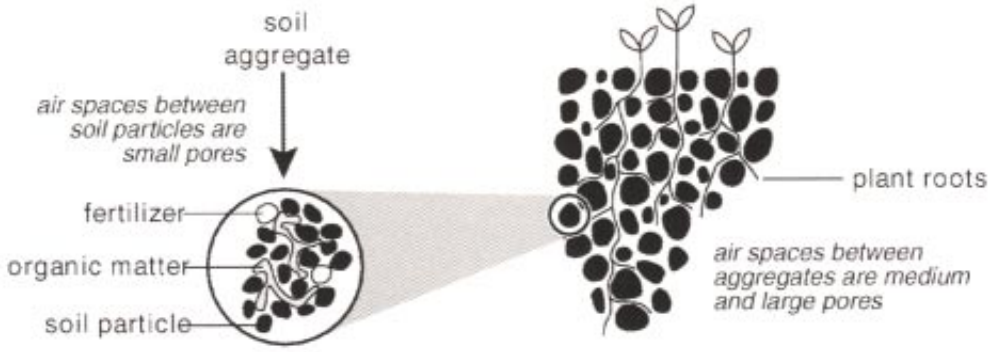
The problem

- A major limitation to productivity is poor soil structure, which restricts root development and uptake of water and nutrients by trees.
- This is not always easily recognised in the field.
- Many orchard management practices, including irrigation method contribute to poor soil structure.
- The effect of poor structure will be even greater in marginal soils, as new orchards are brought into production away from the better soil types in established horticultural areas.

The solution

- Make the soil softer and more porous

Well Structured Soil with a good range of soil pore sizes



What soil pores do

- Small pores (smaller than 0.03mm diameter)
  - store water for plant growth
- Medium pores (0.03 - 0.075mm diameter)
  - allow rapid water to flow towards roots
- Large pores (0.075 - 0.5mm diameter)
  - allow water and air to move into the soil
  - allow excess water to drain away from the root zone
  - ensure the soil is kept friable for unrestricted root growth.

Without enough small pores the soil will be deficient in plant available water.

Without enough large pores the soil will be;

- difficult to irrigate effectivley
- exessively wet
- poorly aerated
- hard enough to limit root growth even when moist

Good soil structure *Poor soil structure*

We need pores in each of these size ranges for effective irrigation and fertiliser use.

Many traditional orchard soil management practices make soil hard and destroy good soil structure causing ideal conditions for waterlogging.

Management practices that destroy soil structure and limit root growth

All pores and particularly the larger ones can be built up during establishment of an orchard (eg by tillage or deep ripping), but can be easily destroyed again over time by;

- Wheel traffic which causes soil compaction.
- Slow settling and coalescence of soil.
- Insufficient gypsum or lime
- Poor drainage
- High irrigation rates, which tend to cause excessive wetness and collapse of pore structure.
- Surface mulching resulting in prolonged excessive wetness.
- Drip irrigation, especially in clay soils, which destroys favourable structure in the wetted zone and encourages concentration of roots in relatively small moist zones.

Creating and maintaining an ideal environment for root development

Deep ripping produces a continuous system of large pores from the surface down into the soil profile.

To maximise the benefits, the deep ripping operation must be accompanied by some method of stabilising the large pores that result, including;

- application of gypsum if the soil is sodic, to prevent soil structure from breaking down into fine particles and clogging up larger soil pores, especially during wetting by irrigation.
- application of lime as an additional source of calcium to maintain soil structure.
- establishment of ryegrass, as its fibrous roots penetrate into the soil stabilising favourable soil structure, softening it and creating new pores.
- hilling soil in the inter-row into "no-till" beds to provide a root zone of well structured, soft, aerated and well drained soil.
- no traffic on the beds, as this will cancel the above benefits
- slower rates of irrigation to prevent excessively wet soil conditions and soil pores collapsing under their own weight.

Ryegrass roots improve soil structure

Steps in orchard development

a) Site selection

- Carrying out a soil survey to identify what soil improvements are required and the need for soil amendments such as lime or gypsum.

- Observing the soil profile, by augering or in back-hoe pits, is now an increasing practice used by growers, because of the high cost investment in irrigation enterprises. A grid of holes clearly shows soil depth and any physical constraints likely to be encountered by root growth. Estimates can then be made of water holding capacity, likely drainage problems, and samples taken for assessing lime and gypsum requirement.

- A map of the area can be drawn up identifying land suitability for different crops.

- These services are offered by consultants.

b) **Addition of Gyspum/Lime** (prior to autumn break in the first year)

- Determine likely response to gypsum, by observing dispersion from a 1cm diameter soil aggregate placed carefully into distilled water and left overnight. A light brown halo effect around the edge of the aggregate indicates dispersion. In highly sodic soil the distilled water becomes completely coloured.

- Determine the need for lime by testing a 1:5 ratio of soil: calcium chloride solution with a pH meter. A value of less than 6 indicates acidic soil and a need for liming.

- Lime application rates for soil structure stabilisation are currently being researched. Advice on specific rates should be sought from the CRC for Soil & Land Management (08) 303 8670, Agriculture Victoria or authors of this leaflet.

- Broadcast gypsum onto the surface at a rate dependant on soil test results. The higher rate should be used if the subsoil is highly sodic.

- Rainfall following the break will help to carry applied gypsum into the soil profile.

c) **Sod seed ryegrass over the whole area** (autumn first year)

- Sow a total of 10-15 kg/ha of a mixture of Kangaroo Valley (early), Concord (mid) and Ellett (late maturing) to spread growth over a longer period.

- To ensure a good establishment use adequate nitrogen and some phosphate fertiliser if required, and control weeds and pests.

Gypsum helps to stabilise soil structure

Deep rip to improve drainage and subsoil friability

d) **Deep ripping** (autumn second year)

- The correct soil moisture for ripping is critical. If too wet ripping tines will leave smeared slots in the ground, and if too dry the soil will shatter and produce large clods and dust.

- Rip through compacted subsoil layers in 3 increments of 20-30cm along the proposed tree line.

- A successful deep ripping is indicated if the majority of soil fragments in the subsoil are less than 20mm in diameter, and with a minimum of dust.

To achieve this;

- Carry out the operation when the water content of the sub-soil is at the plastic limit, or ripped soil fragments will be too large.

  The plastic limit is determined by rolling out remoulded subsoil into a thread. The soil is too wet if the thread can be rolled down to less than 3mm diameter. If the thread crumbles before 3mm it is too dry.

- Don't work too fast - the speed of travel should be adjusted to give the best possible result (small clods, minimum dust).

Design of the ripping equipment is important. The following are suggested design features by Professor G Spoor of Silsoe College, UK (see diagram below);

- tine spacing of 1.5 - 2 times the working depth (approx 1 - 1.5 m for most operations)

- wings should be attached to the tine, with a sweep angle of 90 degrees. Wings improve subsoil loosening 3-4 times compared to a conventional ripper, for a draught increase of only 20-30%.

- width of the wings should be 0.7 -0.8 times the working depth (approx 0.2 m for most operations)

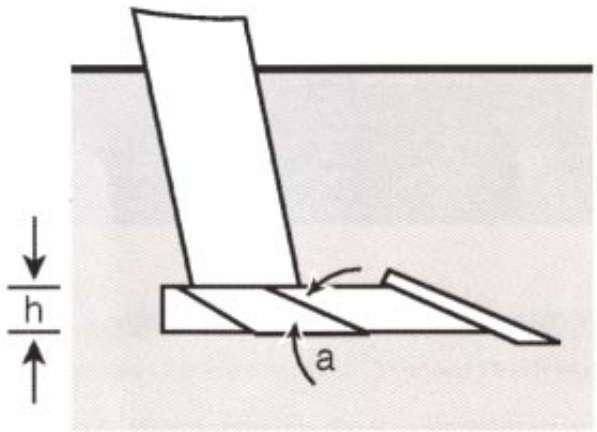
- wing lift should be 60 - 100 mm, with a rake angle of 22 degrees.

- the bottom edge of the wing should be at least 2.5 cm above the working depth of the chisel point.

- The bottom cutting edge of the the wing should be as near horizontal as possible.

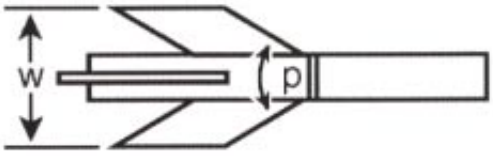
- shallow chisel plough or cultivator tines should be placed ahead of the ripping tines at about half the working depth.

Diagram of Ripping Tine fitted with wings



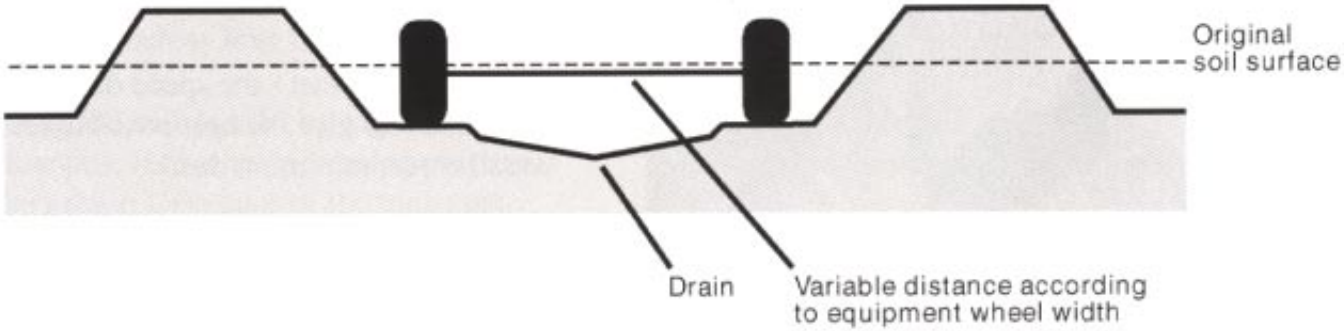
Side view

w width
a rake angle
p sweep angle
h lift height



Top view

Diagram of Bed Shape



e) **Hilling soil into beds** (autumn 2nd year)

- After ripping, form beds along the tree-line with a grader or delver by moving topsoil from the inter-row area. A shallow drain may need to be constructed between the beds.

- Once beds have been formed it is critical that;
  - no further wheel-tracking occurs on the bed area.
  - a cover crop is sown immediately on the bed to protect the surface and stabilise the soil structure with roots.

f) **Irrigation systems established**

- Place mini sprinklers spaced to allow for a slight overlap but with a radius to wet the whole bed.

g) **Sow ryegrass onto the beds** (autumn 2nd year)

- Broadcast onto the surface of the bed the same mixture and rate of ryegrass as used in the previous year.

- This should be done immediately after hilling in early autumn, before temperatures drop.

- A light irrigation may be used to establish the ryegrass. Alternatively sow dry and wait for rain.

- Fertiliser can be broadcast and watered in or applied through the irrigation line, according to the normal orchard fertiliser program.

h) **Spray out ryegrass and plant trees** (spring 2nd year)

- Ryegrass can compete with trees during the growing season and so needs to be sprayed out before tree bud burst with herbicides such as Glyphosate or Spray Seed.

- Ryegrass (living or dead material) is preferrable for soil protection to surface mulching.

- In each subsequent year;
  - allow regeneration of ryegrass during autumn, resow if necessary
  - spray out ryegrass in spring

Ryegrass roots help to keep soil friable

Kill ryegrass in summer to protect soil structure and prevent competition with trees

i) **Irrigate with low rate mini-sprinklers**

- Apply irrigation water at less than 5mm/hr (common rates of 10-30mm/hr are too high).
- Sprinkler type eg Tornado Ray Jet (Blue) at operating pressure 30 psi, delivers 5mm/hr over a radius of 1.6m.
- Drippers are not recommended as they tend to saturate a small wetted zone and cause soil to become hard.

j) **Schedule all irrigations**

- Monitor soil water with a neutron water meter probe or tensiometers placed at 30 and 60 cms in the beds.
- Irrigate at the 'refill point' of the neutron water meter or if the tensiometer reads greater than 60 kPa suction in the lower root zone.

k) **Critical times during establishment and the annual management cycle**

- Immediately after ripping
  - Soil should never be wetted to saturation (Avoid ripping and hilling in wet periods).
- Immediately after hilling
  - Sow ryegrass as soon as possible.
- Commencement of winter rains and at times of high intensity rainfall
  - Beds should be protected with ryegrass and re-seeded if necessary.
- Ryegrass competition at budburst
  - Kill actively growing ryegrass.

References

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