



Sydney Environmental & Soil Laboratory

Specialists in Soil Chemistry, Agronomy
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Soils for Olive Planting: Choosing and Improving

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A Brief Introduction to Understanding, Preparing and Maintaining a Soil for Olive Grove Planting and Production.

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Introduction: Soil Properties

There are basically three profile forms commonly being used for horticulture in humid zone Australia:-

Duplex: Otherwise known as a podsol profile these soils show two distinct horizons, a loamy to clay loam A horizon changing abruptly into a usually heavy clay B horizon. Often “shotgun pellets” or iron/manganese (Fe/Mn) nodules or soft concretions are present at the A/B boundary (called A2 horizon) which is often pale or bleached. These are sure signs of periodic waterlogging in our drought and flood climate.

Gradational: In these profiles the clay content gradually increases with depth and the abrupt change from loam to clay is not present. They can be sandy earth type profiles or more clayey profiles such as prairie soils or Red Earths. The profiles are usually better drained but can show Fe/Mn nodules and a pale or bleached A2 horizon.

Uniform: These can be sand to clay in texture but are basically the same texture all the way down the profile. Some darkening due to accumulated organic matter may be present in the surface and structure may be present in the B horizon. Uniform clay profiles may be finely structured (eg self-mulching Black soils) or coarsely structured (eg deeply cracking clays). Sandy soils can be alluviums next to rivers or even old dune sands.

The profile form is not a soil classification and does not imply anything about the soil chemistry (eg acid or alkaline, fertile or infertile). It is, however, the most important starting point for planning soil preparation from a physical aspect. Each of the three profile types above requires very different soil preparation methods. The Soil Conservation Service of NSW produce high quality soil mapping information that will allow you to understand the soil type on your property. Alternatively services such as those of our company are available to map soils and prepare management plans specific to the property.

The Bathurst, Cowra, Orange area is dominated by Duplex and Gradational soils of a red or yellow B horizon colour. Duplex soils are commonly called “podsolc” soils and most often have a bleached A2 horizon with Fe/Mn nodules indicative of periodically perched water tables or waterlogging in the A horizon following rain. The Gradational soils are mostly Red Earths but show the telltale bleaching of the A2 horizon that also indicates periodic waterlogging. The area immediately around Bathurst is dominated by deep uniform loams and is highly suitable for horticulture.

We are seeing a great many mistakes made in the initial soil preparation for olives. This not only reduces growth rates and harvest potential but also in some cases is resulting in complete lack of establishment, slow growth or progressive death of new groves. Unfortunately the first wave in a new industry is the one that makes all the mistakes and is prone to being preyed upon by unscrupulous or less than competent operators.

The most fundamental and common error we are seeing is planting without truly understanding or taking care for soil drainage. Most soils in the areas of interest to olive growers are of the duplex or podsolc soil type. This means they have a sandy to loamy A horizon generally around 150mm deep but sometimes to 600 mm deep, overlying a clayey B horizon layer of a red or yellow colour. Sometimes they have a sandy pale A2 horizon below the darker A1 horizon. This layer is often quite hostile being acidic, low in organic matter, very low in nutrients, and prone to periodic waterlogging. Periodic waterlogging or poor drainage is indicated by the presence of black and tan coloured roundish nodules (Fe/Mn nodules).

In their natural state these soils profiles can suffer the following productivity problems:-

1. Low organic matter (OM) content. Many Australian soils are naturally low in OM but years of sheep grazing, cropping with inadequate rotation, and excessive ploughing will have further degraded them.
2. Low to very low inherent fertility for horticulture. While they may have supported adequate grazing pasture and the occasional forage or cereal yield, their natural fertility is not adequate to support a high yielding intensive horticultural crop like olives.
3. A strong texture contrast from the A to the B horizon. This inhibits downward movement of water causing a “perched” water table in wet weather, resulting in a very low oxygen subsoil when wet. This also impedes downward extension of root growth. This waterlogging is resented by olives and causes poor growth or death through root rots.
4. Acidity. The soils of the Bathurst Orange area are quite variable, some being highly acidic (usually toward the east), others being neutral (even calcic or sodic) usually in the western areas. The area is complicated by the presence of isolated areas of fluvial and volcanic soils which may not be acidic.
5. Sodidity. Usually confined to the subsoil, a high sodium level is common in yellow subsoils in the area and gets worse with depth. It even occurs in red soil country. High sodium leads to clay dispersion, erosion, poor subsoil structure (and hence root growth), and poor drainage and aeration.

Soil chemistry problems are relatively easy to fix; the issue of deep subsoil drainage is not. The Southern Oscillation Index or El Nino phenomenon affects the Central

Highlands severely. Long periods of drought may lead to a conclusion that dryness is your biggest problem but anyone planting into a severely duplex soil will find real problems of slow decline and even death, for example in the last 2 years when the La Nina event has been strong. Problems are always worst at the bottom of a hill where water accumulates and a strongly bleached A2 horizon full of black pellets is present.

Forget the weather, the telltale signs of poor drainage are in the profile. Olives are very intolerant of waterlogging in duplex soils and the attendant manganese toxicity and oxygen deficit that occurs. We are seeing widespread deaths and poor growth occurring because of Mn toxicity/O₂ depletion in duplex soils during wet periods.

The other profile forms are more forgiving. The ideal profile is probably a Gradational profile or a Uniform one if not too clayey. It is said that clay profiles are no good for olives. This is not true if the clay is well structured and finely structured. It is true that a heavy cracking clay can cause root tearing and severe root penetration problems. However, a cracking clay can be improved and made to crack more finely and into a looser structure by gypsum or lime additions and an organic matter build up program.

Nasty blocky or cloddy clay should be tested for gypsum or lime requirement. These “clay breakers” can have a profound effect on responsive soils and, while better added during preparation, can be added even after establishment to good effect. A heavy clay should also be surface contoured and mounded as they can stay wet for long periods. For the first few years at least a heavy green manuring program is highly beneficial.

Very sandy and low water holding profiles provide the opposite problem, drought and excessive drainage. A heavy green manuring or composting program combined with mulching is the most effective way to increase water holding.

However, the most common soil in your area will be a red or yellow duplex profile prone to periodic waterlogging. What do we do about this?

Contrary to popular opinion any amount of deep ripping does not help. It might loosen the clay subsoil for the few years following planting but does not avoid the perched watertable phenomenon that will occur in high rainfall periods. Careful thought as to how to get the plants out of the perched water table is needed. This can occur by:-

1. Surface contouring to spill excess water. Run on from uphill worsens the problem of perched water tables. By orienting rows off the contour to spill excess water, placing dish drains (intercept drains) at intervals to catch run on and divert it away much can be achieved. In severely duplex soils the technique will almost certainly need to be accompanied by mounding of rows.
2. Hilling or mounding. By scalping the inter-row and hilling it up on to the row we can deepen the topsoil in the planting row. This gets the plant roots off the clay base and above the perched water table at all times no matter how much it rains. The need for hilling is dependent on the depth of the existing topsoil and the slope position. At the bottom of the slope hilling should generally be deeper as

waterlogging will be more severe. The technique used by modern farm forestry is illustrative. They do a complete cultivation and hill up to 500 mm higher than the surrounding levels providing a 500 mm deep mound of loosened topsoil on top of the clay and some remarkable growth rates in farm trees. Ameliorants such as lime or gypsum as well as fertilisers and green manure crops can be incorporated while mounding.

3. Deep systematic drainage. In the worst soils the installation of agricultural drainage pipes can be necessary as well as hilling and surface contouring. Drainage design is a specialist and costly exercise. Think twice about the property!

While doing all this work it is essential that chemical and organic matter deficiencies also be corrected. The ideal properties of a topsoil for olive grove use shown in Table 1.

Table 1. Ideal Olive Soil Properties

Soil Property	Ideal Range
pH	6.0-7.0
Exchangeable Na %	< 7.0
Exchangeable Ca %	65-75%
Exchangeable K %	3 - 10%
Bray P mg/kg	>20 ideally around 50
Topsoil Organic Matter	3-6%
Total N %	0.1-0.20
Density g/cc	< 1.4 in the surface
Free rooting soil depth	500 mm

Olives are highly responsive to improved organic matter and chemical fertility. An understanding of the chemistry and physical properties of a proposed grove is essential before planting occurs or even before purchase of the property. Money saved on a cheaper property may well be spent in bringing the soils up to standard. Soils must be tested and planting preparation methods determined well before work starts.

Almost no natural soils have the ideal characteristics as listed in Table 1. which means that in nearly all cases soils need to be modified before planting and to be maintained and managed so that these characteristics are enhanced and preserved. A theoretical preparation plan on an acidic and nutrient poor yellow duplex soil is worth examining.

Preparation:-

- Starting at least one season before planting apply the requisite lime and superphosphate as well as any trace elements indicated in the soil test report and work deeply to incorporate.
- In the autumn sow a high yielding winter green manure crop mix with 300 kg/ha of urea. The ideal green manure crop in the first instance is a mixed grass/clover sward.

- In late winter or early spring rip three times at intervals across the planting rows. Orient rows slightly off the contour and maintain short rows so that surface run-off can escape.
- Using a grader, front-end blade etc. scalp the inter-row area to produce a topsoil depth of at least 300 mm on the planting rows.
- Deep disc plough the on-row space before planting.
- Plant with additional NPK fertiliser around and in each planting hole.
- Remove root balling by training or pruning roots at planting.

The resultant mix of rotting green manure and fertilisers should give very rapid early growth rates with adequate soil moisture.

Future management of the grove could involve:-

- Annual winter soil testing to plan the fertiliser additions required to keep the soil balanced and high yielding
- Jan/Feb foliage testing to confirm fertiliser effectiveness.
- Use fertilisers annually in winter in the inter-row space to produce green manure
- Feed the plants with this green manure worked in lightly in late winter/very early spring.
- Use herbicides only in the early spring around each plant. Do not maintain bare fallow year round.
- Use summer grasses and mixed naturalised pasture to mow onto the row space as a mulch two or three times during the hotter months.

Green manure cropping is often the only cost effective way to increase soil organic matter levels unless you can get very low cost feedlot manure or compost or even sewage sludge products. Green manure should be worked in a few weeks before plants become active again in spring so that new roots have a rich decomposing humus layer to grow into. Feeding the green manure and ploughing this back into the ground in spring to feed the trees ensures an even and naturally balanced feeding program.

Do not be persuaded by highly expensive organic products or so called bacterial preparations. These are either of no proven value or so expensive as to be unrealistic on a large scale. I remain extremely sceptical of so called “biodynamic” preparations and warn anyone against the “something for nothing” syndrome. A good well-fed green manure crop can produce 10 to 20 tonnes of organic matter per hectare and stimulate trillions of soil microbes and other organisms. Think how much worm castings 10 tonnes of green manure can produce *in situ* for the cost of about 40 kg of seeds and some nitrogen.

Trace element and lime or gypsum additions are also advisable during the initial soil preparation period as they are very immobile and if surface applied will stay close to the surface for many years. They are always better deeply incorporated.

Chemical fallow or constant mowing under groves represents an unsustainable practice leading to soil organic matter and structural decline. Use side-casting mowers to throw mulched inter-row sod growth onto the on-row soil surface. Break

up the sod regularly with planted green manures. All plants grow much better with mulch.

The summer foliage test is a critical period. If done in January there is still time to conduct remedial work such as chelated foliar sprays of calcium, nitrogen or trace elements and the test tell us to include those elements in next years fertiliser program.

If mistakes are made in soil preparation a lot can be done to improve the situation. Instead of hilling, scalp and remove the inter-row topsoil to allow rapid removal of run off and run on. Make breaks in the contour banks if you have planted across the contour on a wet duplex profile. Small changes to surface drainage can make a big difference in periods of excessive wetness.

Warning: We are seeing a lot of very inferior planting stock with coiled root systems, sometimes doubly coiled. Once planted, it is virtually impossible to obtain a good root system with this material and it will strangulate itself or suffer wind-rock. If you cannot get good stock then time spent pruning and correcting the root system teasing out roots and laying them out flat in a shallow but wide planting hole is time well spent.

Summary

- If possible, avoid soils showing manganese nodules in the A/B boundary, otherwise plan to improve them physically, the results will be well worthwhile.
- Treat such soil physically to destroy texture boundaries and create a more gradational soil profile 500 mm deep at minimum.
- Use intercept drains, row orientation, hilling or even subsoil drainage to avoid perched water tables.
- Correct gross deficiencies during ground preparation using lime, gypsum, phosphate, and trace elements as needed. Remember boron deficiencies are showing up widely in olives in Eastern Australia.
- Include green manure in the pre-plant conditioning program and use green manure programs as needed to maintain at least 3% organic matter.
- Use green manure annually in winter and feed it with fertilisers. Shallow plough this in to the entire inter-row in late winter/early spring.
- Use inter-row summer grass sward to mulch rows during the growing season, shading and protecting the soil from drying and heating and stimulating soil organisms. Do not mow more than two to three times a season.
- Use annual soil and foliar testing to manage the crop and calibrate the soil improvement and maintenance program.

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