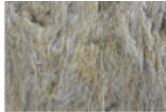


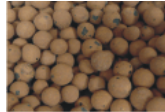


Hydroponic root media guide (Substrates)

Roots require water, oxygen and nutrients at optimum levels. The physical characteristics of the medium will determine how easily these levels can be optimized and maintained. A medium's suitability depends not only upon the physical characteristics of the medium itself but also upon management practices such as feed frequency, volume, etc.

Popular medium types					
	NFT (no media)	Rockwool*	Coconut fibre	Perlite	Expanded clay
					
	Nutrient Film Technique (NFT) provides no medium for roots. Tall plants are held erect by overhead support.	Rockwool is a fibrous material made from molten rock. It is available as compressed slabs, as propagation cubes, or in granulated form. * Rockwool is a trade name. Use of this term refers to all equivalent brands.	Coco coir ('coco') is derived from the husk of the coconut. It is available in a loose, hydrated form, or in compressed dehydrated blocks.	Perlite is a soft, absorbent, granular material. It is produced by heating volcanic rock. It is available in bags of loose fill.	Expanded clay is a hard, granular medium. It is produced by heating clay. It is available in bags of loose fill.
Water holding capacity and system suitability Water holding capacity defines the amount of nutrient solution retained once drainage has occurred after watering. It is this capacity which largely determines a medium's suitability for either 'run-to-waste' or 're-circulating' systems etc. When the water holding capacity is high, the medium retains a high proportion of the nutrient solution from each watering. This water / nutrient source is exploited by the run to waste concept which requires only intermittent watering. The watering frequency is influenced by the water holding capacity. A high water holding capacity generally comes at the expense of "air filled porosity" (see below), arguably a more important characteristic.	NFT requires no medium and therefore the pump must be run continuously. A variation of pure NFT is regular waterings followed by complete drainage (i.e. "pulsed" NFT or "flood and drain"). This draws air into the root mat which in turn can improve oxygenation of roots and provide other potential benefits. Because a high proportion of nutrient from each watering is unused, re-circulating prevents the wastage which would otherwise occur with run-to-waste. Although it offers many potential benefits over media based systems, pump failure can result in plant death within a few hours – especially in hot weather.	Rockwool's high water holding capacity makes it ideal for use in run-to-waste systems. It requires only low frequency watering. Note it is prone to water-logging therefore accurate feed regimes are required. Rockwool is sometimes used in re-circulating systems. Small blocks of Rockwool are commonly used for propagation of cuttings and seedlings which can be subsequently installed in an NFT system.	Coco's high water holding capacity makes it ideal for use in run-to-waste systems. It requires only low frequency watering. Note it is prone to water-logging therefore accurate feed regimes are required.	Perlite's moderate water holding capacity is generally suitable for either re-circulating or run-to-waste systems. It is available in various 'crop specific' grades – finer grades offer higher water holding capacity, whilst coarser grades offer superior air filled porosity.	Expanded clay's poor water holding capacity makes it most appropriate for re-circulating systems. Depending on system design, pump failure can result in plant death within a few hours, especially in hot weather.
Air filled porosity Air filled porosity (i.e. air filled pores) enables the medium to accommodate oxygen for the process of 'respiration', and also aids the removal of the gaseous products of root respiration. Adequate air filled porosity is vital for root development. Approximately 98% of the oxygen that the plant uses is absorbed through its root system. Care needs to be taken not to over-water those mediums having poor air filled porosity – i.e. time must be provided between waterings for oxygen to ingress into the root mat. Although a 30% oxygen, 70% moisture ratio is typically regarded as optimum for mediums, higher levels of oxygen can be desirable.	Optimum aeration is more easily achieved in NFT designed systems. However, if channels are too narrow they can become "choked" with roots. This inhibits flushing with subsequent drowning of roots. The working nutrient solution should be aerated to ensure its oxygen content is adequate.	Provided it is not over watered, Rockwool offers adequate air filled porosity. Feed volumes and frequency must be adjusted as weather changes. Further, as Rockwool ages, it can tend to become compressed from the effect of rootmat expansion. This will reduce the air filled porosity and increase the risk of water-logging.	Coco offers adequate air filled porosity provided it is not over watered. Be diligent to adjust feed volumes and frequency as weather changes. Further, as coco ages, it can tend to become compressed from the effect of rootmat expansion. This will reduce the air filled porosity and increase the risk of water-logging.	Perlite provides good air filled porosity. As discussed above, the coarser grades of perlite provide better aeration than finer grades. Aeration is enhanced when employed in 'flood & drain' systems because the oxygen depleted air is expelled each time the medium is flooded. Re-circulating nutrient should be aerated to ensure its oxygen content is adequate.	Expanded clay provides good air filled porosity. Aeration is enhanced when employed in 'flood & drain' systems because the oxygen depleted air is expelled each time the medium is flooded and replaced by oxygenated air after draining. The working nutrient solution should be aerated to ensure its oxygen content is adequate.

	NFT (no media)	Rockwool*	Coconut fibre	Perlite	Expanded clay
<p>Ability to sterilize</p> <p>Unlike soil culture, hydroponic nutrient solutions and roots are exposed to the atmosphere and are therefore more prone to disease ingress. To minimize this problem, the nutrient solution, medium, roots (etc) should be regularly sterilized.</p> <p>'Inert' mediums (i.e. those that exert zero demand on sterilizing agents) are preferable in hydroponics because they improve the effectiveness of sterilizing agents.</p> <p>For maximum effectiveness, sterilizing agents must yield a non toxic and residual chemical when dissolved in the working nutrient so that complete system sterilization occurs each time plants are watered.</p> <p>Low air filled porosity of media and root mats decreases ability of sterilizing agents to contact roots. This results in lower sterilization efficiency.</p>	<p>NFT systems are easiest to sterilize.</p> <p>Further, the absence of any medium permits routine disease inspection of roots.</p> <p>Ability to sterilize root mat decreases as size and density of root mat increases – i.e. as air filled porosity decreases. Hence wider channels are best - with care being exercised with design to ensure full width of channel is evenly covered by flowing nutrient.</p>	<p>Rockwool is inert and therefore permits the effective use of sterilizing agents.</p> <p>However, its physical structure prevents routine inspection of roots.</p> <p>Ability to sterilize root mat decreases as size and density of root mat increases – i.e. as air filled porosity decreases.</p>	<p>Coco is not inert and can only be treated using certain oxidizing agents.</p> <p>As with soil, it is difficult to conduct routine disease inspections of roots.</p> <p>Ability to sterilize root mat decreases as size and density of root mat increases – i.e. as air filled porosity decreases.</p>	<p>Perlite is inert and therefore permits the effective use of sterilizing agents.</p> <p>To ensure thorough sterilization of roots and medium, 'flood & drain' systems offer optimum delivery of sterilizing agents.</p> <p>Perlite is clean and light which does permit some degree of routine disease inspections of near surface roots.</p> <p>Ability to sterilize root mat decreases as size and density of root mat increases – i.e. as air filled porosity decreases.</p>	<p>Expanded clay is inert and therefore permits the effective use of sterilizing agents.</p> <p>To ensure thorough sterilization of roots and medium, 'flood & drain' systems offer optimum delivery of sterilizing agents.</p> <p>It is clean and light which does permit some degree of root inspection of near surface roots to identify disease symptoms.</p>
<p>Pre-treatment of new medium</p> <p>Do not presume new media are sterile and ready to use without any pre-treatment. Mediums often contain high levels of alkalinity, sodium, chloride or dust and therefore may need to be sterilized, soaked and/or flushed with water or nutrient solution etc. prior to use.</p>	<p>No medium - not applicable.</p>	<p>Rockwool is usually sterile and clean when new.</p> <p>It can be relatively alkaline due to the binding agent used during manufacturing. This can be removed prior to planting by soaking / flushing with slightly acidic * water.</p> <p>* Lower pH to ~5.0 prior to use.</p> <p>Note, ensure to use 'horticultural' grade Rockwool. 'Insulation' grade Rockwool can incorporate toxic binding agents.</p>	<p>Coco can vary widely in quality - check with your retailer.</p> <p>Coco is unsterile when purchased and can potentially harbour disease.</p> <p>It can also contain high levels of sodium, chloride and alkalinity. This can be removed prior to planting by soaking / flushing with slightly acidic * water.</p> <p>Monitor the EC of the run-off water. Flush until the EC of the run-off equals (approximately) that of the input water.</p> <p>* Lower pH to ~5.0 prior to use.</p>	<p>Perlite is usually sterile and relatively pH stable when new.</p> <p>It can however contain perlite 'dust'. This can be removed by flushing with water prior to use.</p>	<p>Expanded clay is usually sterile and relatively pH stable when new.</p> <p>It can however contain clay 'dust'. This can be removed by flushing with water prior to use.</p>
<p>Re-useable</p> <p>To minimize the threat of disease, at the end of each crop remove all plant matter (roots, etc) from the medium then, if possible, sterilize*.</p> <p>Complete removal of old roots/plant matter is necessary as this will eventually decay and provide an ideal environment for disease (and pests).</p> <p>*Sodium hypochlorite solution (bleach) is adequate for this role.</p>	<p>NFT avoids the on-going expense of medium replacement.</p> <p>Compared to medium based systems, NFT is simple to clean-up between crops.</p> <p>Only hardware (channels, etc) needs to be cleaned by thorough wet brushing, hosing down and sterilization prior to replanting.</p>	<p>Rockwool is generally not re-useable.</p> <p>The difficulty of removing roots means effective sterilization is not possible.</p> <p>Hardware needs to be cleaned and sterilized prior to replanting.</p>	<p>Coco is generally not re-useable.</p> <p>The difficulty of removing roots plus the non inert nature of coco means effective sterilization is not possible prior to replanting.</p> <p>Hardware needs to be cleaned and sterilized prior to replanting.</p>	<p>With care and depending on crop type, the majority of roots may be able to be removed from perlite. Screening the loose material may further assist this process. If reuse of perlite is being considered, diligently remove all roots prior to flushing then sterilize with a strong dose of sodium hypochlorite. However, the problem of removing traces of toxic hypochlorite makes reuse unattractive.</p> <p>Hardware must also be cleaned and sterilized prior to replanting.</p>	<p>With care, the majority of roots can be removed from expanded clay enabling its reuse. Tumbling followed by screening may further assist this process. Sterilization can then be effectively employed using a strong dose of sodium hypochlorite. The problem of removing traces of toxic hypochlorite is less than with perlite.</p> <p>Hardware must also be cleaned and sterilized prior to replanting.</p> <p>Some large scale commercial operations use rotary kilns to sterilize clay between crops.</p>
<p>Disposal</p> <p>Bio-degradable mediums can be placed in the garden after use. However, disposal is a significant problem with commercial size systems.</p>	<p>Perfect - Not applicable.</p> <p>NFT avoids the disposal problems associated with medium based systems.</p>	<p>Rockwool is not bio-degradable and therefore must be disposed of in an environmentally friendly manner.</p>	<p>Coco is bio-degradable and effective as a garden mulch.</p>	<p>Perlite is not bio-degradable and therefore must be disposed of in an environmentally friendly manner.</p>	<p>Expanded clay is not bio-degradable and therefore must be disposed of in an environmentally friendly manner.</p>