Substrate cultivation

Technical information sheet No. 3

Chris.Blok@WUR.nl; Erik.vanOs@WUR.nl; Wageningen UR Glastuinbouw; Laith.Waked@ecoconsult.jo; ECO Consult

Why substrate growing?

Substrates or rooting media are materials other than soil in situ used for cultivation. Advantages of using substrates are:

- 5-15% yield increase due to more frequent supply
- Up to 50% yield increase if soil diseases are avoided
- Water saving (50%)
- Fertiliser saving (60%)
- Faster learning by better feedback
- Societal responsibility by minimal emissions of water, nutrients and plant protection products
- Higher water use and area use efficiencies.

Different from soil growing

- Fertilization must meet crops usage; a crop specific recipe must be given and frequent (1 or 2 weeks) analyses are necessary
- Adjustments in fertilization must be made based on the analyses
- Clean water in substrate harms crops, water should always contain fertilizers
- EC fluctuations in substrate harm crops
- Ammonium and urea harm crops (pH)
- Trace elements should be supplied in exact quantities
- The water quality must be known: elements in water need to be subtracted from fertilization

	Soil	Substrates	Unit
Root volume	300	15	L/m^2
Dry Bulk Density	1200	100	kg/m^3
Total Pore Space	40%	85%	%-v/v
Max water capacity	120	12.75	L/m ^{2}
Air at max water	0%	10%	%-v/v
Irrigation frequency	1	10-50	cycles/day
Irrigation volume	1000	100-20	ml/m2/cycle

Irrigation

Frequency and duration per turn depends on the type of substrate. Types with a high water capacity (peat) need less frequent and longer irrigations. Dry substrates (stone wool, perlite) need a high frequency with short turns.

Typical substrates

Thousands of materials are offered:

- Peat: Deep deposits of age-old plant material are processed as granular milled peat, peat fractions or sods for use in containers and bags
- Coir: Coconut husks are processed into coir fibres, the granular coir pith, coir chips and (pressed) coir blocks and slabs
- Stone wool: Molten rock is spun into a fibrous mass and bound together. The resulting mass is cut into plugs, blocks, slabs and granular cubes
- Perlite: Minerals are heated until they explosively expand into a white 0-8 mm light weight granulate which can be graded into size classes
- Tuff: Many gaseous volcanic gravels of different base melts can be found. Materials may be broken and graded into more uniform classes
- Poly-urethane: synthetically made foams with various air and water capacities in granular cubes or slabs.

Peat

Perlite

Tuff

Rockwool

Coir

Poly-urethane

Wageningen UR Greenhouse Horticulture
P.O. Box 20, 2665 ZG Bleiswijk, The Netherlands
Contact: chris.blok@wur.nl
T + 31 (0)317 485679, M +31 (0)6 4640 6154
www.wageningenUR.nl/glastuinbouw

ECO Consult, hydroponic Green Farming Initiative
P.O. Box 941400, Amman 11194, Jordan
Contact: info@ecoconsult.jo
T + 962 (6) 5699769,
www.hgfi.org

Substrate cultivation

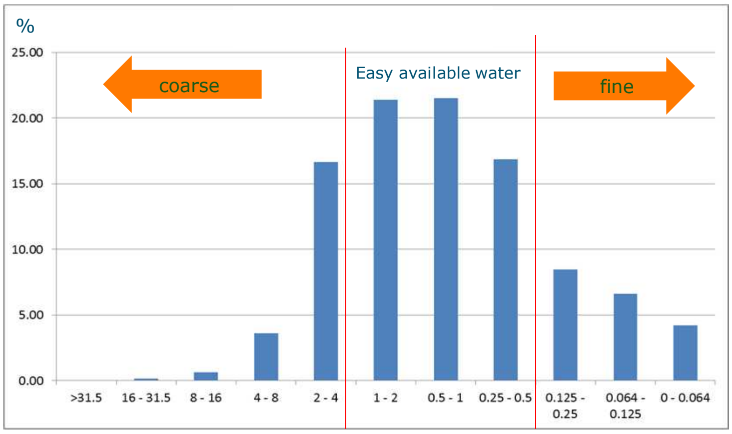
Technical information sheet No. 3

Properties

To work with substrates it is really important to know at all times the water content, the air content, the amount of nutrients and pH.

- Water content is used to start irrigation cycles sufficiently frequent
- Air content is used to avoid over irrigation.
- EC is used to avoid salinity stress and under fertilizing
- pH is used to avoid root damage at low (<4.5) and nutrient uptake problems at high (>6.5) pH

Before delivery it is necessary to know bulk density, organic matter, content, total pore space, water characteristics (water retention curve including air contents, easily available water, water uptake rate), buffer capacity, cation exchange capacity, base saturation, degradability, shrinkage and nitrogen fixation. The table below shows typical values. Note that not all measurements are needed for all substrates.



Typical grain size distribution: preferably particles between 0.25 – 2 cm (easy available water for plant uptake). Too fine particles make the substrate wet; too coarse particles make it too dry.









Parameter	Unit	Milled white peat as harvested	Milled white peat after liming	Coir pith	Rockwool	Perlite	Tuff	Compost
Dry Bulk Density, DBD	g/cm^3 DW	100	100	120	70	100	250	250
Acidity, pH	pH	3.8	5.5	7.1	7.5	6.9	7.2	8.1
Electro Conductivity, EC	dS.m1	0.1	0.3	0.8	0.1	0.1	0.2	2.1
Water Retention, PF1	%-v/v	87	87	70	87	70	25	55
Easily Available Water, EAW	%-v/v	25	25	25	40	30	15	15
Water Uptake Rate, WUR	%-v/v	20	20	50	35	45	15	15
Air content at saturation	%-v/v	3	3	10	8	15	20	5
Total Pore Space, TPS	%-v/v	90	90	80	95	85	45	60
Cation Exchange Capacity, CEC	meq/100g OM	50	50	25	n.a.	n.a.	n.a.	25
Nitrogen Fixation Index, NFI	mmol.L^{-1}	1	1	4	n.a.	n.a.	n.a.	8
Organic Matter (Content), OM	%-w/w DW	99	99	95	2	n.a.	n.a.	60
Stability	mmol O_2/kg OM/h	2	2	4	n.a.	n.a.	n.a.	12
Shrinkage	%-v/v	40	40	15	n.a.	n.a.	n.a.	20
Buffer capacity	meq/L	50	50	-20	-5	-5	-20	-30
Base saturation	%-CEC	0%	85%	40%	n.a.	n.a.	n.a.	60%
Blue = always necessary		gree[illegible]ot critical				n.a. = not applicable		