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Performance of cucumber (*Cucumus sativus L.*) and sweet pepper (*Capsicum annuum L.*) in various local growing media, as alternative for rockwool in Saudi Arabia

W. Voogt, A. Alharbi, M. Almuwalid, S. Alsahly, J.B. Campen, H. van der Heide, M.E. Abdelaziz, M. Osman, I. Tsafaras, M. Qaryouti and F. de Zwart

Background

Rockwool and Perlite are the commonly used growing media in soilless cultivation. Though Peat and Coir are becoming more popular as a renewability resources. In general, the choice of the growing media depends on the crop, growing system, physical, chemical, and biological properties of the substrate and not at least the cost. Growers world-wide, try to adopt locally manufactured or locally available substrates. Furthermore, the international trend for substrate development tends toward using of national resources and renewable raw materials. Therefore, searching for cheap and locally produced organic soilless growing media has been the subject of several studies either for ornamental plants or vegetable crop production.

Objective

This work aims to study the capabilities of tow local growing substrates, date palm waste (DPW) and volcanic rock (VR), as potential alternative to rockwool. The physical and chemical aspects for both substrates will be examined for cucumber and sweet pepper grown in soilless cultivation systems.

Methods

- For first trial (cucumber), two date palm waste (DPW) sources (shredded pruned leaves and a mixture of shredded diverse parts of the whole tree) from date palm trees (*Phoenix dactylifera L.*) were obtained from a local deposit near Riyadh. DPW were rinsed and leached out with water to reach an EC of <0.5 mS cm1-, before planting, .
- For the second trial (sweet pepper), the shredded leaf DPW was selected and graded into three categories based on the fractions size (<8 mm, 12-8 mm and >12 mm), thus washed with desalinated water, then autoclaved at 100°C .
- Granulated volcanic rock and DPW with particle size from approx. 10 - 12 mm was applied in polystyrene (PS) boxes for the first year. In the 2nd experiment VR was applied in the same bags as DPW. Perlite (standard commercial quality, middle fine fraction (12 -7 mm) and RW were used as references in both trials .

	Substrate	Source/type	Pre- treatment [a]	Containment [b]	Volume (Litter. Plant^{-1})
Cucumber	DPW 1	Shredded leaves	1,3	PE boxes	5.2
	DPW 2	Shredded whole plant parts	1,3		5.2
	DPW 3	Mix of DPW1 and DPW2	1,3		5.2
	VR	Volcanic rock granules (2 - 20 mm)	3		5.5
	PRL	Perlite (0.6 - 3 mm)	4	Bags	4.5
	RW	Rockwool (Grodan expert)	4	Slabs	4.7
Sweet pepper	DPW 1	Shredded leaves, 2 - 8 mm	2,3	Bags	4.5
	DPW 2	Shredded leaves, 8 - 12 mm	2,3		4.5
	DPW 3	Shredded leaves, >12 mm	2,3		4.5
	VR	Volcanic rock granules (2 - 20 mm)	3		4.5
	PRL	Perlite (0.6 - 3 mm)	4		4.5
	RW	Rockwool (Grodan expert)	4	Slabs	4.7

Table 1. Details of the growing media. a1=Manually separation in coarse and fine particles, washing to reach EC of leachate <0.5 mS cm2 ; 1-=washing to reach EC of leachate <0.5 mS cm3 ; 1-=pre-planting: rinsing with nutrient solution and drain to waste; 4=Saturation with nutrient solution only; 5=saturation with nutrient solution + extra Ca (+ 8 mmol L^{-1}) and drain to waste. b=Boxes of polystyrene boxes of 12×20×35 cm (length, width, height respectively), which were fully open at the top and with drainage holes at the bottom. Bags made of black-white polyethylene (PE) (white outside), of approx. 15×20×100 cm (l×w×h), drainage slits 1.5 cm above bottom. Slabs of 7.5×20×100 cm (l*w*h), wrapped in white PE foil, drainage slits at bottom

Results

- Regarding the chemical properties of DPW, the measured data identified high variation in EC values and ion composition (Table 2).
- Water retention of DPW is initially very low, but increases over several days, and makes difference if the medium stays in contact with free water.

Properties	Substrate					
	DPW 1	DPW 2	DPW 3	RW	VR	PL
Water holding capacity (%)	70	65	59	98	60	80
Bulk Density (g cm^{-3})	0.25	0.18	0.31	0.04	1.06	0.21
Organic matter (%)	22.2	22.2	22.2	0	0	0
EC (mS m -$^{-1}$)	4.6	4.6	4.6	0.015	0.013	0.012
CEC (cmol kg^{-1})	37.5	37.5	37.5	0	9.5	0
pH	6.7	6.7	6.7	7.6	7.5	7.2
Weight of (16 L) slab (kg)	3.5	2.5	2.1	0.7	12.3	3.4

Table 2. . Physical and chemical properties of the growing media used in the sweet pepper trial.

Treatment	Cucumber	Sweet pepper			
	kg . m^{-2}	# Fruits . m^{-2}	kg . m^{-2}	Fruit weight (g)	BER (%)
DPW1	24.1	67.8	10.9	160.7	10.8
DPW2	23.5	66.3	10.6	159.0	18.0
DPW3	23.5	68.0	10.6	156.0	17.7
VR	21.7	79.1	13.3	168.4	10.7
PRL	25.0	78.4	12.6	160.8	15.7
RW	26.7	74.2	11.9	160.5	18.8

Table 3. Effect of different growing media on the total yield (kg m^{-2}) of cucumber in the first trial and the total yield (kg m^{-2}), the fruit production (fruits m^{-2}), average fruit weight (g fruit $^{-1}$) and the incidence of blossom end rot (% BER, w/w) of sweet pepper in the second trial.

- In cucumber trial, production of the three DPW treatments was similar with PRL but was %10 lower than RW (table 3).
- In sweet pepper trail, DPW presented similar yield production with VR and PRL
- The DPW substrates showed strong decomposition, after three months of cultivation, thus, the infiltration of the drip water was visibly obstructed.

Discussion

- Roots from volcanic, PRL and RW were clearly more abundant than the organic date palm waste types (DPW). Strikingly there were much less roots at the bottom of the substrate with VR and PRL than with RW, whereas with VR and PRL there were many more roots inside the substrates.
- Despite the high rate of decomposition, and the poor root development, the crop performance of the DPW treatments was surprisingly good.
- The growth reduction of the DPW treatments, may have been aggravated by the yield differences, as these plots gradually became in more shaded positions compared to the well growing inert media treatments.

Conclusion

- Local materials could be an applicable alternative for the commonly used growing media if the substrates and the way of application fit with the substrate properties.
- This became quite clear with volcanic rock, when after modifications of the way of application of the material the results strongly improved.
- Although the results of the reference substrates RW and PRL were better than date palm waste substrates in both crops, there are perspectives for further improvements.
- The lesser growth and reduced yield have likely been caused by the rapid degradation of DPW, which resulted clearly in waterlogging and bad conditions for root development.

Wageningen University & Research
BU Greenhouse Horticulture & Flower Bulbs
P.O. Box 6700 ,123 AB Wageningen
Contact: ilias.tsafaras@wur.nl
T + 31 (0)317 48 89 10, M +31 (0)6 24 92 17 55
www.wur.nl/

National Research And Development Center For Sustainable Agriculture (Estidamah)
Riyadh Techno Valley, King Saud University, Riyadh
12373, Saudi Arabia
Contact: info@estidamah.gov.sa
https://estidamah.gov.sa