Trends in Rooting Media in Dutch Horticulture during the Period 2001-2005: the New Growing Media Project

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Abstract

An overview of the developments in the area and volume of substrates used for horticultural rooting media in Holland in the period 2001 to 2005 is given. The overview is followed by a discussion of some trends in society and technology including the interest of public and society in a possible substitution of peat, an increase in the use of locally produced renewable carbon based substrates and an increase in nutrient recirculation for soil grown crops. In reaction to growing public concern about peat harvesting for horticultural purposes in parts of Europe, Dutch growers, researchers, potting soil producers, an auction and traders initiated in 2003 a research program named the New Growing Media Project. The aim was:

- **To assess the technical and economical potential of peat alternatives.**
- **Develop experience and knowledge of growing on alternative mixtures.**

During 2004 and 2005, fifteen growers cultivated green and flowering container plants on alternative mixes. The 2004 season was used to test larger numbers of potting soils with relatively small numbers of plants. The 2005 season was used to test the most promising potting soils with larger numbers of plants. The results showed that for *Hedera* and *Schefflera*, the ultimate alternative mix was superior to the commercial standard used. For five species, *Anthurium*, *Chrysanthemum*, *Gerbera*, *Spathiphyllum* and *Castanospermum*, the alternative mix proved equal to the commercial standard. For eight species, *Azalea*, *Guzmania*, *Poinsettia*, *Rosa*, *Saintpaulia*, *Adiantum*, *Crassula* and *Ficus*, results were poorer than on the standard medium. The growers however, felt confident the alternative mixes could do better if the growing system, often the irrigation frequency, could be adapted to the experimental growing medium. *Begonia* gave poorer results with the new mix. The percentage peat used in the mixes was reduced from 77% on average in the commercial standard mixes to 30% on average in the new mixes. The most popular alternatives were coir products which increased from 17 to 40%. Other alternatives used were various barks, rice hulls, perlite, wood fiber, composts, and rockwool granulate. Those alternatives were used in mixtures from 5 to 30%. General conclusions include a growing interest in locally produced composts, granulates and fibers and for materials with properties such as a high initial air content combined with an improved rewetting rate.

INTRODUCTION

The aim of this article is to illustrate, quantify and discuss developments in the area and volume of substrates used for horticultural rooting media at present. For practical reasons the overview is restricted to rooting media in Holland in the period 2001 to 2005. Data from diverse sources such as the government, the industry and RHP were combined (Anon., 1999, 2005, 2007; van der Knijff, 2007; van Woerden, 2007). The data are discussed in the light of trends in society and technology. The reaction of the industry to one such trend (growing public concern about peat harvesting for horticultural purposes) is reported (van Leeuwen et al., 2005). The project, initiated in 2003, was called "The New Growing Media Project". It was preceded by related work in other countries (e.g. Prasad and Maher, 2004).

AREA AND VOLUME DEVELOPMENTS

Since 1960 rapid changes have occurred, first when soil was substituted by peat and then by mineral wool for a number of crops. Other media were introduced such as expanded clay, pumice, bark, perlite, rice hulls, coir products and wood fiber.

Data on the period 2001-2005 are based upon a number of sources (Anon., 1999, 2005, 2007; van der Knijff, 2007; van Woerden, 2007). In the period 2001-2005, the overall area of plants grown on rooting media other than soil in situ under glass and in Holland was virtually stable for vegetables and ornamentals (Table 1). The minor areas of glasshouse tree crops and glasshouse soft fruit increased. The areas of individual crops however often increased or decreased by more than 10% (Tables 2 to 4). One development not reflected in the area figures are that the average greenhouse area per owner increased by 10-30%. As a consequence the number of owners is decreasing. It is now common for growers to own two or more greenhouse facilities and new greenhouses frequently surpass an area of 10 hectares.

Figures for individual vegetable areas show an increase of more than 20% between 2001 and 2005 for tomato. The area ratio round-truss-specialty tomatoes is now probably <30->40-20% respectively. The sweet pepper area increased a little less than 5% and the cucumber area stabilized at 600 ha after a rapid decrease in previous years. The area of egg plant was not recorded but is around 100 ha and stable. The area of strawberry increased some 45% probably to the expense of the area not covered by glass. Radish decreased with probably over 30% as competition from abroad is fierce, and indeed this crop may disappear from Holland altogether.

The cut flower area is decreasing under the pressure of price competition from abroad (Table 3). The areas of rose, chrysanthemum, gerbera, freesia and to a lesser extend lily show decreases of almost 20% in the period 2001-2005. *Anthurium* and orchids showed a growth of 6 and 10% respectively.

The bedded plants and flowering and green container plants showed area increases of 12, 12 and 2% respectively. The volume produced per area unit also increased, mainly because of the effects of transport automation and camera sorting investments over the last decade. Thus the demand for substrates increased even more than proportional with the area increase. *Phalaenopsis* became the leading flowering plant, which boosted the use of pure bark media.

In the vegetable market, slabs of mineral wool are the dominant rooting medium. Various coir slabs are also in common use and perlite slabs are common in cucumber growing. Synthetic materials, wood fiber and flax are offered but uncommon. In the cut flower market mineral wool is also the leading rooting medium but coir and to a lesser extent peat is also common for rose and gerbera. Orchids are grown on granulates of bark, synthetics and mineral wool, and root systems may be wrapped in mineral wool sheets on transplanting to a larger container size. In gerbera crops the use of containers instead of slabs increases. Coir products along with Jiffy peat plugs or mineral wool cubes topped with a disc and a mineral wool plug are used as substrates.

In the market for bedded plants and container plants, many crop and growing system specific mixes are used. The total market volume sold increased by 10% (Table 5). Individual constituents are shown in Table 6. The volume of the most important constituent, peat, is stable. The volumes of coir products (coir dust, chips and fibres) increased by over 50%, and the volume of bark sold doubled in the period 2001-2005. The use of perlite increased by 20% and the use of compost rose from almost nothing to over 70.000 m^3.

A particular problem for peat suppliers is the price increase of the sods. The sods are broken into various grades of fractionated peat. Fractionated peat is now increasingly replaced with coir fiber, chips, bark or perlite.

TRENDS IN SOCIETY AND TECHNOLOGY

Social Responsibility

In the period 1970-2000 substrate growing facilitated and benefited from the public wish to have nutrient solutions recirculated and to ban the use of methyl bromide for soil sterilization. Somewhat later the public pressed the need for (slab) substrate recirculation. In the period 2001-2005 possible new claims from the public came into focus.

From Switzerland and the UK came the growing concern of the public that peat is used irresponsibly. The two main arguments are the permanent damage to peat bogs and related eco-topes and the release of carbon dioxide. The carbon dioxide release is identified as a major contributor to global warming. Carbon dioxide is released by draining the peat bogs while harvesting them, by the harvested peat when used as potting soil and by harvesting, transporting and processing the potting soils (Maanen, 1998; Verhagen and Boon, 2008). Major research programs have now started to get overviews of the maintenance and use of European peat bogs and mires.

Another trend in society is the re-use of agricultural waste. The European Union forbade the use of agricultural waste products as landfill. Major programs were launched to facilitate new forms of re-use (Grub's Up; WRAP). One of the possible uses of the vast amounts of material involved is compost for use in potting soils. To meet the quality standards of the potting soil industry composts need to be produced from specific materials and under strict control. Possible new techniques to treat, wash and sort these materials are hoped to result in the development of peat diluents. New techniques are also attempting to upgrade some fibrous rest materials into fiber materials with the right qualities for potting soil mixes (Beerepoot, 2003; Toonen and Maliepaard, 2004).

Other public interests are the call for further recirculation of nutrient solutions and a more positive labour image. The call for recirculation is most felt in chrysanthemum growing which is totally soil-based and where the need for automation is urgent (Pekkeriet and Sonneveld, 2007). Other high density soil-grown crops may benefit. Recently it was suggested to extend the EKO organic growing certificate to include crops grown in substrate systems. This could mean a breakthrough in the amount of organic grown vegetables offered.

Materials promoted by the government and others for use in horticulture are composts of green waste, municipal waste composts, mushroom waste composts, composted bulk products of grasses, reeds, hemp, flax and jute. Not very long ago these materials were largely refused by horticulturists but some are now regarded with growing interest and the quality of the products has increased considerably (Rabou et al., 2001).

Green waste compost is now used as a regular component of potting soil mixes in percentages up to 20% (Aendekerk, 2001). The EC of the material offered is now an acceptable 1.0-2.0 $dS.m^{-1}$ whereas stability according to OUR (oxygen uptake rate) is 5-10 mg $O_2.g^{-1}$ organic matter. Green waste is constant in quality as the base materials, mainly woody green waste from parks, are carefully selected and composted with more careful management of temperature, water content and aeration.

Composted and torrefied reeds have been offered successfully as potting soil components in percentages from 20% up to 80% (Langeveld et al., 2005). The stability of the torrefied material according to OUR (oxygen uptake rate) is 2-4 mg $O_2.g^{-1}$ organic matter.

Hemp and flax fibers have been offered as a 100% product in the form of slabs. The material is up to now too vulnerable as according to OUR (oxygen uptake rate) the stability is 10-15 mg $O_2.g^{-1}$ organic matter.

Automation

Increasing labour costs drive the development of ever more ingenious ways to transport and harvest plants with increasing automation. Container plants are leading the field in moving plants from one climate to another and in changing the plant density stepwise, in addition to full automation. The same transport techniques are used to have the plants camera sorted into various groups which receive different treatments, either to arrive at one homogeneous batch of end product or to create several batches with different delivery dates just as the customer requires.

Rose growers have already followed the example of the container plant growers and reduced their labour costs by 30% and more by using moving gullies in combination with central harvesting. To do this even more effectively the rose plants may be sorted into groups with the same production stage (Kapchina et al., 2002; van Weel, 1996). They are therefore sometimes singled which means every plant is rooting in a separate unit of rooting medium as in container growing (Fig. 1). Gerbera cut flower growers are using similar transport techniques and harvesting the flowers in a central place, usually the main path. Labourers do not have to move from plant to plant and the working conditions can be improved by shading and ventilation (Fig. 1).

These techniques are now experimentally followed by vegetable growers. To move their crops special gutters have been developed which are transported sideways through the greenhouse (van Weel, 2005). Another experiment has attempted to keep the stem length constant throughout the growing season by lowering the low and bare end of the stem into a mist chamber (Fig. 2). In the mist chamber roots are formed and the old rooted stem is cut and thrown away. The plant head is kept in the same position throughout the cultivation period.

A final group of crops are plants with a high number of stems per square meter like *Chrysanthemum* and *Lisianthus* (Buwalda et al., 1994). Growers are now experimenting on whole greenhouse scale with moving mini gutters filled with rooting media (Pekkeriet and Sonneveld, 2007). This will get these crops out of the soil, recirculating irrigation water and fertilizers and automate production of them in one single technological leap (Fig. 3).

THE “NEW GROWING MEDIA” EXPERIMENT

Background and Goal

In 2003 Dutch growers, researchers, potting soil producers, an auction and a trader embarked upon a research program named New Growing Media (van Leeuwen et al., 2005). The New Growing Media project was organized in reaction to growing public concern about peat harvesting for horticultural purposes in Switzerland and the United Kingdom (WRAP, 2006).

The aim was to assess the growth, technical and economical potential of the use of rooting media with a reduced amount of peat and to develop experience and knowledge of growing on the alternative mixtures.

Method

During 2004 and 2005, 15 growers cultivated 16 species of green and flowering container plants on alternative mixes. Each mix was tailored to the specific needs of the greenhouse involved, i.e. not only to the crop but also to the irrigation system of the greenhouse. The first growing season was used to test a series of potting soils on small numbers of plants; the second season was used to grow commercial batches of up to several thousands of plants on the most promising mix. Plants from the larger batches were sold off through the normal channels.

The plant species in the experiment were *Gerbera*, *Spathiphyllum*, *Hedera*, *Castanospermum*, *Guzmania*, *Crassula*, *Rosa*, *Saintpaulia*, *Dendranthema*, *Anthurium*, *Ficus*, *Schefflera*, *Begonia*, *Adiantum*, *Poinsettia* and *Azalea*.

The criteria for accepting a potting soil constituent as peat substitute in this project were strict. The materials had to be totally acceptable to the growers in terms of proven quality in growing media witnessed by a RHP certification, a comparable price level and no restrictions in the quantities offered in the market. This resulted in the use of perlite, coir chips, rice hulls, barks, coco fiber, wood fibre, mineral wool granulate, coir pith and composts.

Several critical aspects were monitored such as shelf life, water buffering capacity, physical stability, nitrogen fixation, pH, EC. The shelf life was measured on 10 plants per batch in a standard test by the Holland Flora Auction and starts with two days transport simulation followed by a retail simulation of 7 days for flowering plants and 12 days for green plants. The retail simulation was performed with the common foil package. Finally a 6 days consumer simulation was added. The water buffering capacity was measured by weighing on 5 plants per batch within the shelf life measurement. Physical stability was measured with the oxygen uptake rate method OUR. Nitrogen fixation, pH and EC were monitored with the more common methods.

To create the individual mixtures for each grower and crop, the potting soil producers of the growers, seven in all, were invited to participate. In concert with the experts from RHP and WUR Glasshouse Horticulture these potting soil producers designed and produced the new mixes. The new mixes were only delivered when the chemical and physical analyses proved that the new mixture was sufficiently close to the favourite mixture used by the growers so far.

Immediately after cultivation started plants were randomly selected for substrate analyses throughout the cultivation period and for crop monitoring. Based on these analyses, adaptations in irrigation and fertilizer level were made as far as possible. For *Begonia* and *Guzmania* it was deemed necessary to add some plant analysis as well. At the end of the cultivation period, parameters of commercial interest were recorded. These ranged from weighing to counting flowers or measuring leaf areas. All plants except *Azalea* were subjected to a transport simulation.

Results

The percentage peat used in the mixes was reduced from 77% on average in the commercial standard mixes to 30% on average in the new mixes. The most popular alternatives were coir products which increased from 17 to 40%. Both peat and coir are broad definitions covering a range of materials with different properties. Thus 10 types of peat were replaced by four types of coir, various barks and six other alternatives including rice hulls, perlite, wood fiber, composts, and mineral wool granulate. The alternative media excluding coir products increased from 5 to 30% (Table 7).

The results showed that for *Hedera* and *Schefflera*, the ultimate alternative mix was superior to the commercial standard used. For five species, *Anthurium*, *Chrysanthemum*, *Gerbera*, *Spathiphyllum* and *Castanospermum*, the alternative mix proved equal to the commercial standard. For eight species, *Azalea*, *Guzmania*, *Pointsetia*, *Rosa*, *Saintpaulia*, *Adiantum*, *Crassula* and *Ficus*, results were poorer than on the standard medium. The growers however, felt confident the alternative mixes could do better if the growing system, often the irrigation frequency, could be adapted to the experimental growing medium. *Begonia*, gave poorer results with the new mix.

The most common differences requiring adapted practices in the use of new growing media were their generally higher pH and EC, their higher degradability and their drier nature (Fig. 4). The higher pH and EC could be met with changes in the base fertilization as well as in the maintenance fertilization. The increased degradability caused extra nitrogen fixation and loss of volume. Besides restricting the maximum percentage of compost and wood fiber used, adaptations in the nitrogen fertilization were applied. The generally drier nature of the mixes required adaptations in irrigation frequency but this was not always possible as some compartments also contained batches of plants on the traditional rooting medium. Incidental problems were the exact dosing of growth regulators and minor problems with plant hole drilling in wood fiber occurred.

Impact

In 2002 environmental organizations and retailers in the United Kingdom agreed upon a covenant to reduce the volume of peat in potting soil from 95% down to 10% in 2010. This however did not result in a specific demand for reduced peat or 100% compost grown container plants. The general opinion of Dutch growers is that no stricter rules will follow. This is in contrast to the British nursery stock producers who already have to deliver outdoor ornamentals in containers with less than 40% peat for at least deliveries to public projects.

CONCLUSION

From the area developments and the New Growing Media project it is concluded that the demand for particles and fibers to partly replace fractionated peat and to bring air and structure into potting soil media will increase. Furthermore there is a public demand to reuse locally produced carbon sources not only as compost but also as alternative particle or fiber material. Automation will drive the use of moving gullies and this may decrease the irrigation possibilities and increase the importance of water redistribution in substrates of new specific pre-shaped fixed shapes. The properties which then become increasingly important are a high initial air content in combination with an increased rewetting rate. The new materials will have to maintain a level of stability and inertness which is close to that of more traditional materials.

Although many products are offered as peat substitutes, the actual use of these materials is only slowly increasing. It is definitely possible to make potting soil mixes with much less or even no peat but the change is not yet economically feasible and may, in the face of the merit and importance of peat, never become feasible.

The use of substrates will probably increase as there is a definite public interest to increase the use of nutrient recirculation. Experiments with systems without substrate at all are already included.

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Tables

Table 1. Area under glass in hectares in the Netherlands.

Year	Vegetables		Ornamentals	Tree crops	Soft fruit	TOTAL
	heated	unheated				
2001	3984	287	5845	376	32	10524
2002	4018	270	5823	390	38	10539
2003	4053	267	5769	379	71	10539
2004	4019	248	5692	395	40	10394
2005	4165	280	5616	433	46	10540
%2001/5	104%		104%	115%	144%	100%

Table 2. Areas of vegetable crops in hectares in the Netherlands.

Year	Tomatoes			Sweet pepper	Cucumber	Strawberry (under glass)	Radish
	Round & beef	Truss	Cherry				
2001		1150		1200	650	110	-
2003	-	-	-	1213	639	137	-
2004	407	873	73	1205	623	141	139
2005	376	963	84	1236	631	161	109
%2001/5		126%		104%	100%	145%	>73%

Table 3. Areas of cut flower crops (ornamentals) in hectares in the Netherlands.

Year	Rose	Chrys.	Lilly	Orchid	Gerbera	Freesia	Anthurium
2001	921	753	271	194	256	215	90
2002	907	755	272	222	253	200	86
2003	853	702	266	216	246	198	95
2004	848	679	273	233	227	191	96
2005	780	598	255	214	212	167	95
%2001/5	85%	79%	94%	110%	83%	78%	106%

Table 4. Areas of bedded and container plants in hectares in the Netherlands.

Year	Bedding plants	Container plants	
		Flowering	green
2001	492	701	582
2002	489	691	581
2003	507	737	575
2004	543	767	573
2005	550	788	589
%2001/5	112%	112%	101%

Table 5. Volumes of potting soil traded in cubic meters.

	2001	2005	%2005/1
Total potting soil market	4,000,000	4,400,000	110%
Total peat market	3,500,000	3,600,000	103%
Greenhouse potting soils		1,200,000	
Greenhouse peat part		850,000	
Greenhouse others part		350,000	
Mineral wool products (slabs only)		300,000	

Table 6. Volumes of potting soil constituents traded in cubic meters.

Potting soil constituent	m^3 in 2001	m^3 in 2006	%2005/1
Coir products	150,000	250,000	167%
Bark	100,000	200,000	200%
Perlite	85,000	100,000	118%
Composts	10	65,000	>300%
Mineral wool granulate	50,000	50,000	100%
Clay (fresh)	25,000	30,000	120%
Expanded clay	15,000	15,000	100%
Pumice	15,000	15,000	100%
Sand	15,000	15,000	100%
Wood fiber	1000	14,000	>300%
Rice hulls	10,000	10,000	100%
Others	10,000	10,000	100%
Vermiculite	3,000	8,000	267%
Sphagnum	1,000	5,000	>300%

Table 7. Examples of two traditional formulations and their New Growing Media equivalent.

Traditional	New Growing Medium
55% Baltic 0-40 mm	30% Baltic 0-40 mm
15% Milled black peat	25% French bark
30% Coir/fiber mix	30% Coir/fibre mix
	15% Compost
30% Coir	30% Mineral wool granulate
20% Irish coarse	30% Fine bark
40% Peat moss	25% Milled peat 0-40
10% Perlite	15% Perlite

Figures

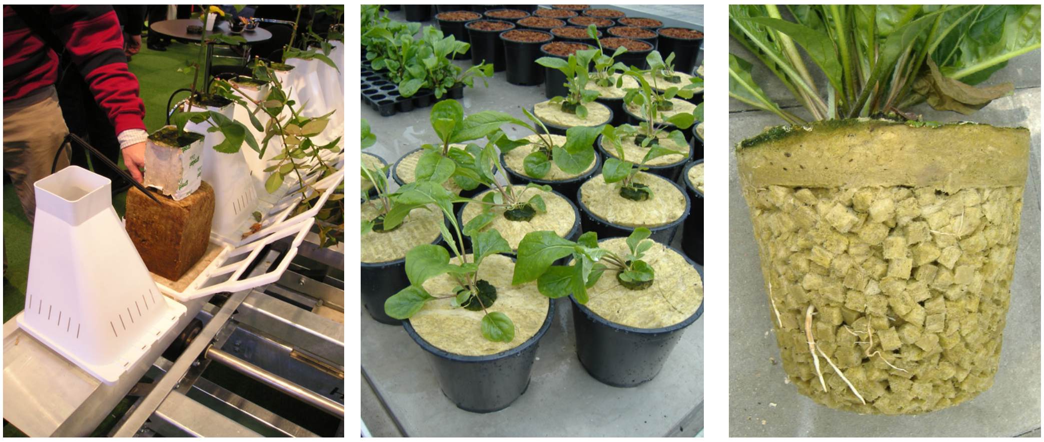

Fig. 1. From left to right: transportable rose system with singled mineral wool blocks on a moving gully; gerbera in containers; filled with mineral wool cubes and topped with a mineral wool disc for transplanting propagated gerbera in a mineral wool plug.

Fig. 2. Left tomato and right cucumber in a system with a static position of the tomato heads, lowering of the stem into the rooting system and a rooting environment with nozzles (aeroponics) and rooting along the stem.

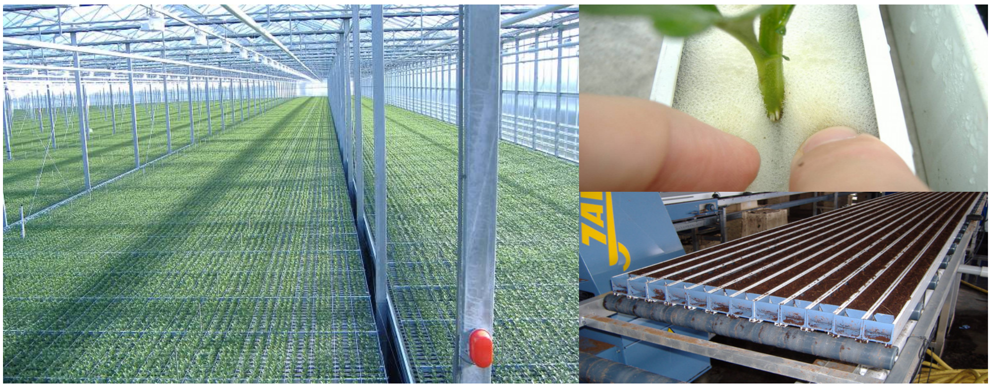

Fig. 3. Left a high planting density crop (chrysanthemum) system without paths and with (right hand) a moving gully system fit for entering cuttings in media as coir (blow) or foam (above).

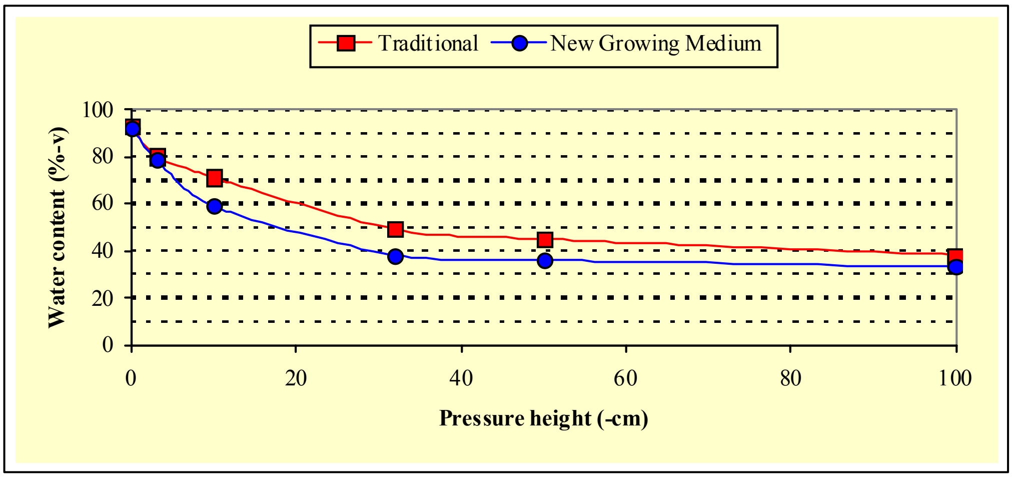

Fig. 4. Typical difference between a traditional and a new growing medium as found in the New Growing Media project.

Fig. 5. Imported coir fiber before reworking.