International Journal of Horticultural Science 2005, 11 (4): 75–78
Agroinform Publishing House, Budapest, Printed in Hungary
ISSN 1585-0404

Effect of physical properties of horticultural substrates on pepper transplant development

Kappel N. and Terbe I.

Corvinus University of Budapest
Faculty of Horticultural Science, Department of Vegetable- and Mushroom Growing
H-1118 Budapest, Ménesi út 44

Summary: Pepper transplants were grown in trays using 6 different growing media. Trays were filled in a loose and in a compact manner with the 5 different peats and coconut coir. Measurements were made for the most important physical parameters of each single medium studying their effect on transplant development. Results indicated that compaction had had a beneficial effect on the germination of the transplants and on the rate of their development.

Key words: transplant growing, peat, coconut coir, growing media physical properties

Introduction

The use of artificial soil mixes have by now become very common in horticultural production under intensive production conditions (*Wilson*, 1983). The quality of the root medium is one of the most important issues in transplant production, too (*Biernbaum*, 1992). As to the determination of the physical properties of the media, there is no unanimous consensus on the characteristics to be measured and the methods to be applied. As the medium are used for different purposes, i.e. compressed soil blocks, loose filling, consequently bulk density may vary considerably and the measuring technique applied must be suited to this (*De Kreij* et al., 1989). A seed tray with a loose fill and a compressed soil block may differ as much as 100% in the bulk density of the material used (*Günther*, 1983).

Among the characteristics bulk density, pore space, air and water capacity and particle size distribution are indicators which determine the physical properties of a material. The weight and volume of a given medium are influenced by water content, compaction level and particle size distribution (*Wilson*, 1983). *Waller* et al. (1983) also highlight the importance of knowing composition, water and organic material content. Several researchers have demonstrated in their studies that total pore space of a root medium is inversely proportional to the bulk density (*Beardsell* et al., 1979; *Bunt*, 1983; *Hanan* et al., 1981).

Peat has long been used as basic material for seedling soils and potting soils both for vegetables and ornamentals. Besides the use of peat base mixtures the use of peat substitutes is becoming more and more common (*Forró*, 1997). Coconut (*Cocus nucifera* L.) coir, which is the mesocarp of the fruit, could become a very suitable peat substitute thank to its chemical and physical properties very similar to those of peat (*Bragg* et al., 1993; *Savithri* et al., 1994).

In transplant media water often appears as a non-limiting factor because it can be applied at any frequency in accordance with the growing requirements (e.g. floating trays, automatic overhead irrigation structures etc.). Instead, the question of aeration is considered as a matter of primary importance. The aeration of the growing medium can be increased at least in three ways. The first is the use of a coarser medium (increase of particle size). However, most growing media have a fine particle size in order to ensure the even filling of the transplant tray. The second is the increase of cell depth in the transplant tray (increase of container height). However, growers tend to prefer the shallower transplant trays. Except for the earliest planting out times, in outdoor production the role of soil block based transplant growing is gradually replaced by the tray method (*Slezák* et al., 2005). The increase of cell depth will also increase the volume of the water and medium in the cell. *De Kreij* et al., (1989) applying several measuring methods, tested 22 growing media. By subjecting the samples to artificial compaction they received a higher bulk density in the measurements and found that water occupied a greater proportion of the pore space and accordingly the proportion of air was lower.

Arenas et al. grew tomato transplants in media containing different ratios of peat, coconut coir, perlite and vermiculite. In the investigation of the media they received results identical with other research reports (*Martinez* et al., 1997; *Prasad*, 1997; *Wever* et al., 1994), namely that coconut coir and peat have the same bulk density, on the other hand coconut coir has a higher total pore space, water capacity, pH, EC and C:N ratio. Studying the transplants they found no difference between the single media in the aspect of total germination, however they observed that the mixture containing a higher proportion of perlite retarded germination. This can be explained by the fact that peat, coconut coir and vermiculite have a higher water capacity than perlite, which is necessary for optimal germination (*Cantliffe*, 1998). According to the findings of *Agut* (1984) the physical characteristics of peats have a greater influence on plant growth than the chemical parameters.

Verdonck et al. (1983), after having tested several materials, concluded that the materials used for making artificial soil mixtures have different physical characteristics, in particular, have different contents of air and readily available water. The question whether the water held in a medium is available or unavailable depends on how far the roots are situated from the water and at which force it is adsorbed to the particles of the medium. The water in the medium is readily available to plants only in the case when the roots are very near to one another (*Fonteno*, 1989).

Material and method

In this transplant growing trial the objective was to find out whether the filling of the transplant trays in a loose or in a compact manner had any influence on the rate of transplant development. The pepper seedlings were grown in trays. Seed was sown directly into KITE trays of 187 cells. 4 different peats: (AgroCs peat: Baltic peat from highmoor (white peat); Hungarian lowmoor peat; Novobalt peat: Baltic peat from highmoor (white peat), Hels peat: highly decomposed Baltic peat from raised bogs (frozen black peat)) and coconut coir peat were used as transplant growing media. During the filling of the trays the mixtures were placed in the cells loosely in one case and by applying compaction in the other. In the course of transplant growing the nutrient supply was provided by the adding of fertilizers, while the pH of the acid peats were raised by feed lime (*Table 1*).

Besides the most important chemical parameters some important physical parameters were also determined, such as bulk density, mechanical composition, capillary rise and water capacity values (*Győri* et al., 1998). The following observations were made for the transplants: germination rate, the size, weight and dry matter content of those transplants ready for selling.

The transplants were grown in a heated plastic tunnel at the experimental farm of the university with a sowing date of April 5th.

Results

Determining the bulk density (*Table 2*) of the single substrates also in our case the result was that its value had increased in response to compaction, approximately by two times. As a result, on the other hand, the value of total pore space had decreased compared to the substrates in the trays with loose filling. Since through compaction the pore space available for water to occupy had also been reduced, the values of water capacity had decreased, too.

Table 2. The most important physical parameters of the single treatments

Treat-ment	Bulk density g/cm^3	Total pore space %	Max. water capacity %	Cap. water capacity %	Min. capacity %
0	0.181	94.66	488.49	352.67	182.31
1	0.298	89.96	287.03	250.33	167.11
2	0.085	94.76	732.67	149.70	177.01
3	0.194	88.04	327.77	131.54	181.41
4	0.267	93.45	337.54	265.35	165.90
5	0.416	86.97	214.55	199.67	157.43
6	0.105	87.12	809.11	249.15	299.66
7	0.209	79.91	438.36	378.78	308.76
8	0.194	88.55	471.98	351.89	180.37
9	0.31	81.74	302.16	270.21	173.84
10	0.088	90.29	1035.99	816.41	434.24
11	0.165	84.06	563.48	528.06	394.12

Table 1. Treatments applied in transplant growing

Treat-ment	Tray filling manner	Substrates		Futor kg/m^3	PEAT-MIX kg/m^3	Super-phosphate kg/m^3
0	loosly filled	50 V% AgroCs peat	50 V% Hungarian peat	1.5	2	2
1	compact filled	50 V% AgroCs peat	50 V% Hungarian peat	1.5	2	2
2	loosly filled	100 % AgroCs highmoor peat		3	2	2
3	compact filled	100 % AgroCs highmoor peat		3	2	2
4	loosly filled	100 % Hungarian lowmoor peat		0	2	2
5	compact filled	100 % Hungarian lowmoor peat		0	2	2
6	loosly filled	100 %Novobalt peat		3	2	2
7	compact filled	100 %Novobalt peat		3	2	2
8	loosly filled	100 % Hels dark brown highmoor peat		2	2	2
9	compact filled	100 % Hels dark brown highmoor peat		2	2	2
10	loosly filled	100 % coconut coir peat		0	2	2
11	compact filled	100 % coconut coir peat		0	2	2

Mechanical composition of the materials used for transplant growing was determined by means of sieves of different mesh size. The particle size distribution of the single components is reported in weight % in Figure 1. As it is apparent from the figure, the majority of the substrates are characterized by the dominance of the particles ranging from 2-4 mm and 400 μm-1.6 mm in size.

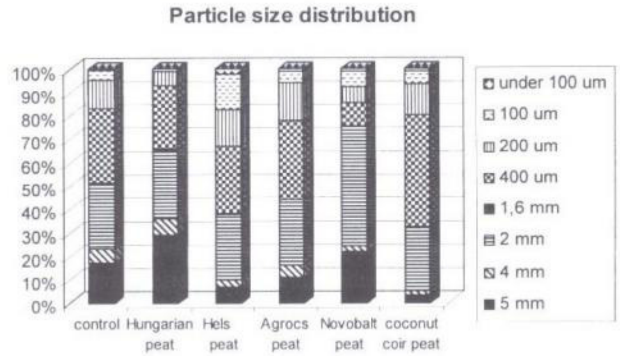

Figure 1: Mechanical composition of materials used

In the medium in contact with a free water surface water will rise in the pores. This characteristic is connected with the particle composition. The height of capillary rise is inversely proportional to the diameter of the pores involved in water rise (*Di Gleria* et al., 1957).

It is apparent in Figure 2 that among the materials tested it is coconut coir that has the best capillary lift. For the highmoor peats (Novobalt peat, AgroCs peat), on the other hand, this capacity was very poor.

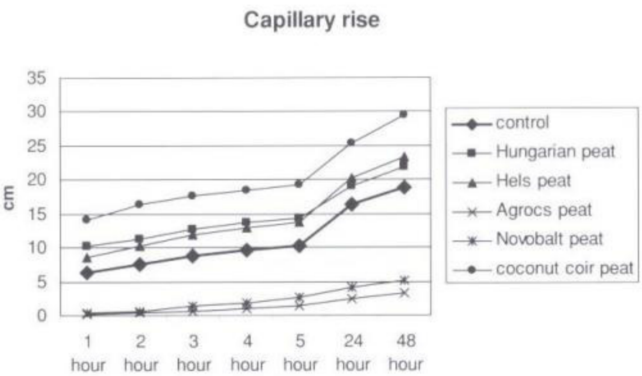

Figure 2: Capillary rise of materials used

In each treatment we observed the germination rate of the seeds (Fig 3). The poorest germination% was recorded for the coconut coir with loose filling, while compaction improved it considerably. Germination was the most dynamic in the trays with Hungarian lowmoor peat, both in the case of loose filling and compacted filling.

Results of the pepper transplants as grown in the single media are reported in Fig. 4. Measuring the fresh weight and height of the transplants for each medium it was the compacted trays that gave bigger transplants, and this tendency was the most pronounced with the Hungarian peat, Hels peat and coconut coir.

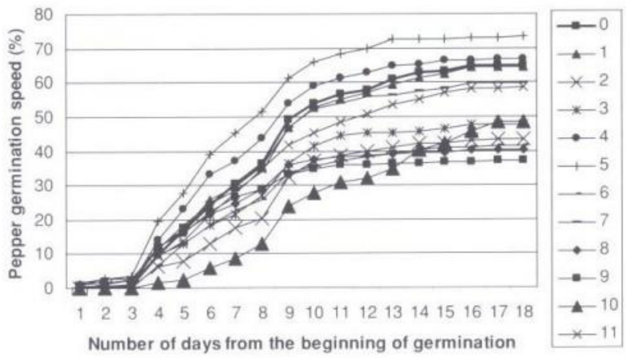

Figure 3: Germination rate of pepper

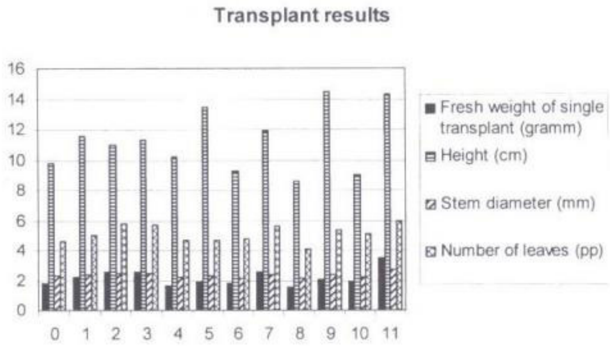

Figure 4: Effect of treatments on pepper transplant development

Conclusions

Measuring the most important physical characteristics of the 6 different media used for growing transplant in trays and filling the trays in a loose and in a compact manner, results indicated that compaction had had a beneficial effect both on pepper seed germination and on subsequent transplant development in all of the cases. Studying the physical parameters of the media, in the same way as other researcher, we saw that compaction had increased the bulk density of the media, on the other hand, pore space and thus water capacity values had diminished. Despite of this fact, the transplants showed better development. The reason could be that water in loose peat mixtures is easily available to pepper plants only in the case when the roots are very near to one another.

References

Agut, A. (1984): Response of pothos in ten greenhouse media. Acta Hort. 150: 245–253.

Arenas, M., Vavrina, C.V., Cornell, J.A., Hanlon, E.A. & Hochmuth, G.J. (2002): Coir as an alternative peat in media for tomato transplant production. HortScience 37 (2): 309–312.

Beardsell, D.V., Nichols, D.G. & Jones, D.L. (1979): Physical properties of nursery potting materials. Scienta Hort. 11:1–8.

Biernbaum, J.A. (1992): Root zone management of greenhouse container-grown crops to control water and fertilizer use. HortTecnology 2 (1): 127–132.

Bragg, N.C., Walker, J.A.R., Stentiford, E. & Tantini, M. (1993): The use of composted refuse and sewage as medium additives for container grown plants. Acta Hort. 401: 155–165.

Bunt, A.C. (1983): Physical properties on mixtures of peats and minerals of different particle size and bulk density for potting substrates. Acta Hort. 150: 143–153.

Cantliffe, D.J. (1998): Seed germination for transplants. HortTechnology 8: 499–503.

Di Gleria J., Klimes-Szmik A. & Dvoracsek M. (1957): Talajfizika és talajkolloidika. Akadémiai Kiadó, Budapest

De Kreij, C. & De Bes, S. S. (1989): Comparison of physical analysis of peat substrates. Acta Hort. 238: 23.–36.

Fonteno, W.C. (1989): An approach to modeling air and water status of horticultural substrates. Acta Hort. 238: 67–74.

Forró E. (1997). Fosszilis nitrogénkészletünk, a tőzeg kertészeti hasznosításának és védelmének ellentmondásai. XI. Országos Környezetvédelmi Konferencia Kiadványa. 1997. október 14–16. Siófok 227–235. p.

Günther, J. (1981): Physikalische Eigenschaften von Kultursubstraten und Substratzuschlagstoffen. Gärtnerbörse+Gartenwelt 31: 714-716.

Győri D., Palkovics M.né. & Matusné S.K. (1998): Helyszíni és laboratóriumi talajvizsgálatok. Egyetemi jegyzet, Keszthely

Hanan, J.J. , C. Olympos & C. Pittas (1981): Bulk density, porosity, percolation and salinity control in shallow, freely draining, poting soils. J. Amer. Soc. Hort. Sci. 106 (6): 742–746.

Martinez, F.X., N. Sepo & J. Valero (1997): Physical and physicochemical properties of peat-choir mixes and the effects of clay-material addition. Acta Hort. 450: 31–46.

Prasad, M. (1997): Physical, chemical and microbiological properties of coir (cocopeat). Acta Hort. 450: 21–27.

Savithri, P. & K.H. Hameed (1994): Characteristics of coconut coir peat and its utilization in agriculture. J. Plant Crops 21: 1–18.

Slezák K. & Irinyi B. (2005): Tálcában nevelt karalábé palánták trágyázási rendszere. „Lippai János-Ormos Imre-Vas Károly" Tudományos Ülésszak 2005. október 19-21., Budapest, Összefoglalók 412. p.

Verdonck, O., Penninck, R. & De Boodt, M. (1983): The physical properties of different horticultural substrates. Acta Hort. 150: 155–160.

Waller, P.L. & Wilson, F.N. (1983): Evaluation of growing media for consumer use. Acta Hort. 150: 51–57.

Wever, G. & Van Leeuwen, A.A. (1994): Measuring mechanical properties of growing media and the influence of cucumber cultivation on these propeties. Acta Hort. 401: 27–34.

Wilson, G.C.S. (1983): The physico-chemical and physical properties of horticultural substrates. Acta Hort. 150: 19–32.