Review on Agriculture and Rural Development 2022 vol. 11 (1-2) ISSN 2677-0792
DOI: 10.14232/rard.2022.1-2.92-97

COMPARISON OF DIFFERENT SUBSTRATES FOR ORGANIC SEEDLING PRODUCTION

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ABSTRACT
Propagation from seedlings is generally applied in the horticultural sector and it has many advantages including earlier harvest and more efficient resource (land, time, energy and seeds) utilization, as well as healthy and homogenous plant production. In conventional large-scale horticulture, seedling cultivation has already become a separate sector. The basis of successful seedling production is the use of the suitable substrate. The physical and chemical quality of the growing medium is crucial. There can be significant differences among the growing media available at the domestic market. For own substrate, farmers put different mixtures of peat, perlite and nutrients together according to a unique recipe.According to the Regulation (EU) 2018/848 on organic production and labelling of organic products, only organic seed and seedling can be used for organic plant production. Therefore, seeds, fertilizers, plant protection and disinfection substances are allowed to be applied only when authorized for use in organic production by the regulations. Recently there are only a few professional organic seedling producers in Hungary. Most of the organic farmers produce their own seedlings. For this purpose, commercially available certified organic growing media, or home mixed substrates are used.In this study, two commercially available organic substrates (Florasca Bio B and Klasmann KKS Proline**)** are compared with two typical farmer mixtures: peat with pelleted cattle manure and peat with compost. The physical and chemical properties of the substrates are investigated and presented.

Keywords: organic farming, vegetable production, seedling, substrate, peat

INTRODUCTION

Propagation by transplants is a long-established practice in vegetable and ornamental plant production. Cultivation from seedlings has many advantages like safer germination, earlier harvest, and more homogenous, healthy crop population (PASCUAL ET AL., 2018) A disadvantage is the increase in production costs.
Conventional farmers, producing on higher scale, obtain ready-to-plant transplants from the so-called seedling factories. The separation of seedlings production from crop production is a global trend in vegetable and ornamental plant production (PASCUAL ET AL., 2018). This tendency can be observed in intensive organic production as well. However, in Hungary it is typical, that organic vegetable farmers still use their own seedlings.
One of the most critical elements of successful seedling production is the use of proper substrate. The characteristics of good seedling growing media are their disease- and weed seed-free status and their adequate chemical and physical properties to support plant growth. Substrates should have a high-water holding capacity and should not lose its structure after irrigation. It is also important to contain enough macropores for the leaching of excess water (Verdonck ET AL., 1984, Tüzel ET AL., 2020).
These organic substrates are usually mixtures of soil, sand, peat and organic fertilizers. Peat is widely used as a soilless potting substrate in horticulture because of its high

nutrient exchange capacity and good physical characteristics (Raviv, 2005). However, in recent years there is an increasing discussion about the environmental and ecological impacts of peat extraction. The nutrients required for early development are partially covered by the nutrient content of peat, which is continuously and slowly revealed. In most cases from the third week of seedling growth, it is necessary to apply additional fertilizing (Amha 2012). In commercial substrates certified for organic farming, manure or compost are used for this purpose (Tüzel ET AL., 2020).For recent years farmers made their own mixtures based on their own recipes. Nowadays, horticultural growing media are produced in large quantities in the EU (more than 30 million m^3/ year) (Schmilewski, 2009).

According to the dual expectations of the holistic view and the regulation of organic farming, seedlings should originate from organic production (Burnett ET AL., 2016). That means not only the seed but also the used substrate, and fertilizers should fulfill the requirements of organic regulation.

Today, there are already commercial mixtures available for farmers and for hobby gardeners as well. Organic farmers can use these products but only if the organic certification body of the country approves them.

The aim of our investigation was to examine the different seedling substrates allowed to use for Hungarian organic farmers and to compare their soil characteristics with homemade mixtures.

MATERIALS AND METHODS

In 2022 four substrates were listed on the positive list for organic vegetable seedling production. Only two of them were available on the market, the Florasca BIO ‘B’ type (FB) and the Klasmann KKS Proline Bio Potgrond (KPP).

After making interviews with organic farmers, two commonly used own recipes were chosen for testing, the peat and pelleted manure (PM), and the peat and compost (PC) mixtures. The physical and chemical properties of the substrates are investigated.

The properties of the investigated seedling substrates are shown in Table 1-4, according to the information provided on the packaging of the commercial products.

Table 1. Florasca BIO ‘B’ type of substrate (FB). Properties according to producer

Ingredients	Hungarian grey cattle manure and Hanségi peat moss
Organic matter content	min 50%
N content	>0.3%
P_2O_5 content	>0.1%
K_2O content	>0.1%

Table 2. Klasmann KKS Proline Bio Potgrond (KPP). Properties according to producer

Ingredients	Mixture of premium quality frozen black peat and TerrAktiv FT® component

EC value	350 mS/cm (± 25%)
pH value (H_2O)	6.0
Salt content (g/l)	1-1.8
Organic N total (mgN/l)	350-450
Mineralized N (mgN/l)	80-120
P_2O_5 content (mg/l)	250-350
K_2O content (mg/l)	350-500
MgO content (mg/l)	100-200

Table 3. PM farmer's recipe: peat + Tribu 3-3-3 pelleted cattle manure. Properties of Tribu 3-3-3 according to producer

Ingredients	Peat: Latagro KB2 pH neutral 1% Pelleted cattle manure: Tribu 3-3-3 (cattle manure 80%, horse manure 20%)
N content	2.8 %
P_2O_5 content	3 %
K_2O content	3 %
Organic carbon	38 %
Organic matter	65%
Humic acids	6%
Fulvic acids	5%
Moisture content	16%
pH	7
C/N ratio	13

Table 4. PC Farmer's recipe: peat + compost

Ingredients	peat: Latagro KB2 pH neutral (50% weight percent)
	compost (50% weight percent)

The compost is from Buda Arboretum of the Hungarian University of Agriculture and Life Sciences (MATE) where only plant originated materials are composted. No additional nutrient supply and plant protection substances were used.
The Hungarian Standard MSZ-08-0012 contains the methods for physical, biological and chemical analysis of peat and peat mixtures.

Examined parameters are: Bulk density (g cm^{-3}), Particle size (mm), pH (H_2O), Humus content (%), Total organic matter content (%), Total water-soluble salt content (%)

Physical and chemical properties were examined in the Laboratory of MATE, Institute for Environmental Sciences, Buda Campus.

Data was analysed by one-way analyses of variance (ANOVA). Significance of differences between means were analyzed by Tukey's multiple comparison test at $p < 0.05$. All statistical analyses were performed using the IBM SPSS Statistics 27 software. The main effect means are presented in figures.

RESULTS

Physical properties of the substrates

The highest bulk density was found in commercial substrate Florasca B (FB) and a similar value in peat and compost mixture (PC). A very low level of bulk density was measured in peat and manure substrate (PM) (Table 5).
The particles were divided in five groups according to their sizes. The highest number of particles above 6.3 mm, was measured in case of FB and PM. And the highest number of particles ranging 3.15 - 6.3 mm and 2.5 - 3.15 mm were also found in FB. The smallest particles were found in the highest number in PC (Table 5).

Table 5. Physical properties of the investigated substrates

Substrates	Bulk density g cm^{-3}	Particle size (g/100g sample) x>6.3 mm	Particle size (g/100g sample) 3.15 mm-6.3 mm	Particle size (g/100g sample) 2.5 mm-3.15 mm	Particle size (g/100g sample) 1.0 mm-2.5 mm	Particle size (g/100g sample) 0 mm-1.0 mm
FB	0.6618	28.81	17.16	7.15	27.83	18.89
KPP	0.3248	12.98	9.85	5.71	33.56	37.82
PC	0.6496	3.87	9.97	4.81	21.33	59.84
PM	0.1675	26.76	8.94	4.72	23.73	35.42

Chemical properties

The pH values ranged between 6.3 and 6.6 for all substrates. There were no significant differences among the values.
Investigating the humus and organic matter content, the commercial product KPP shows the highest values. In case of humus content this is significantly higher than in the other substrates. (Figure 1.)

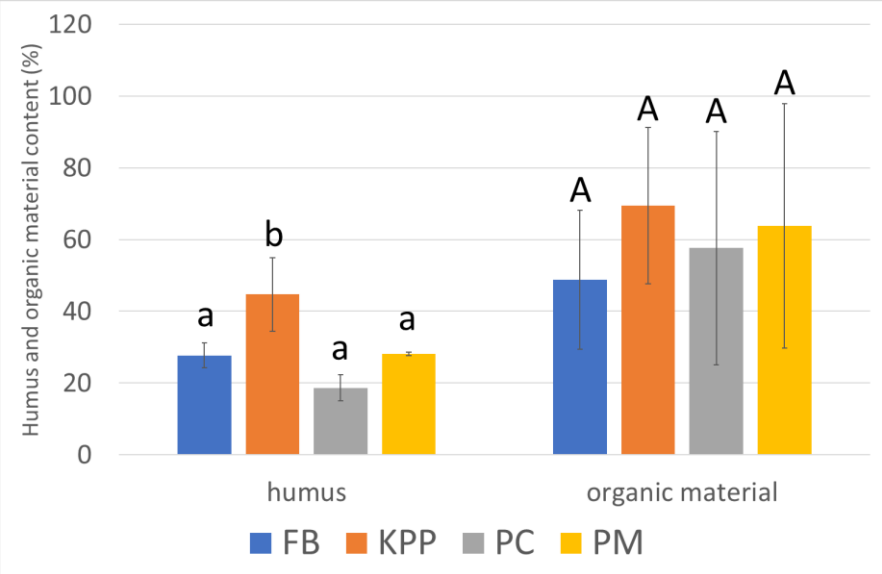

Figure 1. **Humus and organic material content of the different substrates. Different letters within columns are for significant differences among the substrates (Tukey p<0.05)**

The total water soluble salt content ranges significantly between wide values, the lowest is 2330 mg/kg in PC substrate and the highest values is 8246 mg/kg in KPP. (Figure 2.)

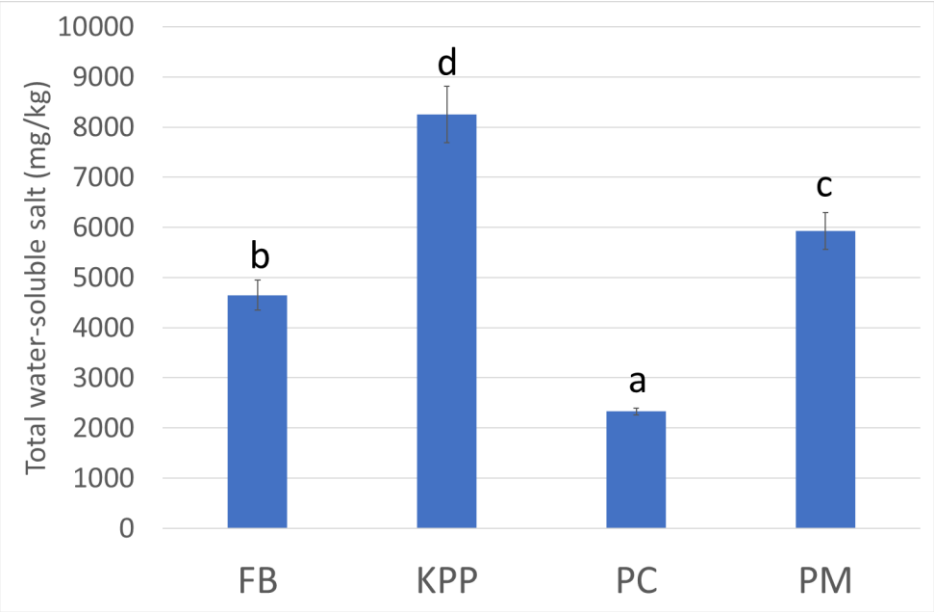

Figure 2. **Total water-soluble salt content of the different substrates. Different letters within columns are for significant differences among the substrates (Tukey p<0.05)**

DISCUSSION

According to Tüzel ET AL. (2020) the acceptable value of bulk density in a growing medium is under 0.4 g cm^{-3}. In our investigation two of the substrates, the commercial KPP and mixture PM met this recommendation.

The optimum particle size should be between 0.25-2.5 mm (Tüzel ET AL., 2020). Taken the two smallest particle values together, in PC mixture, 81.17% of the particles fell into this range.

Tüzel et al. (2020) suggested that the pH of a substrate should be slightly acidic (5.5-6.5). All of the investigated substrates fit in this range.

In a good quality substrate, the total organic matter content should be over 80%. This high amount was found only in KPP substrate.

According to the literature, none of the investigated substrates fulfill all the recommendations. Large differences were observed by the quality parameters such as humus content, total water-soluble salt content.

After a closer look at the Hungarian market for available and accepted organic seedling substrates, it can be stated, that the farmers have only limited sortiment of products and there is only minimal information available about these.

Nowadays, with increasing importance of organic farming, the demand for vegetables from these farms will also increase. That results in the growing need for professional organic seedling production. Therefore, it is important for successful organic production to have enough available seedling substrates which meet the requirements of the organic

regulation and the expectations of farmers regarding the high-quality properties of these substrates.

REFERENCES

Amha, Y., 2012. Influence of peats of different origins and decomposition degree on germination and early growth of Chinese Cabbage. European Journal of Horticultural Science 77, 211–218.

Burnett, S.E., Mattson, N.S., Williams, K.A., 2016. Substrates and fertilizers for organic container production of herbs, vegetables, and herbaceous ornamental plants grown in greenhouses in the United States. Scientia Horticulturae, Recent advances in organic horticulture technology and management - Part 1 208, 111–119. https://doi.org/10.1016/j.scienta.2016.01.001

Hungarian Standard MSZ-08-0012. Physical, biological and chemical analysis of peat and peat mixes

Pascual, J.A., Ceglie, F., Tuzel, Y., Koller, M., Koren, A., Hitchings, R., Tittarelli, F., 2018. Organic substrate for transplant production in organic nurseries. A review. Agron. Sustain. Dev. 38, 35. https://doi.org/10.1007/s13593-018-0508-4

Raviv, M., 2005. Production of High-quality Composts for Horticultural Purposes: A Mini-review. HortTechnology 15, 52–57. https://doi.org/10.21273/HORTTECH.15.1.0052

Schmilewski, G., 2009. GROWING MEDIUM CONSTITUENTS USED IN THE EU. Acta Hortic. 33–46. https://doi.org/10.17660/ActaHortic.2009.819.3

Tüzel, Y., ÖztekiN, G., Tüzel, İ. hakkı, Duyar, H., 2020. Growing Media in Organic Seedling Production. Ege Üniversitesi Ziraat Fakültesi Dergisi 603–610. https://doi.org/10.20289/zfdergi.755975

Verdonck, O., Penninck, R., De Boodt, M., 1984. THE PHYSICAL PROPERTIES OF DIFFERENT HORTICULTURAL SUBSTRATES. Acta Hortic. 155–160. https://doi.org/10.17660/ActaHortic.1984.150.16