Research of the elasticity of transplant – growing substrates after watering

Kappel, N.[1], Zsivánovits, G.[2], Tóth, K.[1] and Slezák, K.[1]

[1]*Department of Vegetable and Mushroom Growing, Szent István University, H-1118 Budapest, Ménesi Str. 44.*
[2]*Department of Physics-Control, Szent István University, H-1118 Budapest, Somlói Str. 14–16.*

Summary: It gets more and more popular to grow transplants in different trays for the field vegetable growing. The best transplant-growing substrates in the world are made of peat. The peat is applied to provide an optimal supply of plants with water and air. To improve the water regulation and the structure of the mixtures there are often mineral matters used in different amounts. By measuring the physical properties of soil mixtures based on peat, the flexibility can be measured by Stable Micro System type table penetrometer. Our measuring confirmed the increase of bulk and flexibility of different kinds of peat by watering.

Key words: transplant-growing, soil mixture, peat, physical properties, watering, elasticity, penetrometer

Introduction

Soils may be described by their physical, chemical and biological properties. The physical nature of the soil may be examined in two states: either in textural or in structural state. The soil has only one textural state, however, its structural state may be innumerable under the influence of different factors *(Sitkei & Mészáros,* 1965).

The most important function of the soil is supplying the plants with oxygen, water, or rather, with nutrients dissolved in water. This function requires the proper ratio of the three soil phases and is possible only with soil where harmful compaction doesn't occur. After *Eitzinger* (1991), Ouwerkerk and Soane (1994) the soil may be regarded as compact if soil resistance is higher than 3 Mpa. *Szöllősi* at al. (2001) have proved hat soil resistance higher than 4 Mpa never occurs in uncultivated soil (in soils being in the natural state). In cultivation however, it often surpasses this value under the depth of cultivation.

Soil compaction has been studied on almost 14 000 ha arable land since 1987 (*Birkás* et al., 1997). *Várallyay* (1996) has classified Hungarian soils according to their tendency to physical degradations. The effect of the different cultivation systems has been studied by several authors (*Birkás* et al, 1996; *Gyuricza* et al, 1998; *Schmidt* et al., 1998).

Plant growth in soil block mixtures is closely related to the mechanical solidity of the blocks. The more compact and hard the soil block, the less it meets the physiological demands of the plants. Lauenstein's experiments (1958) with soil blocks produced under different pressure have proved that root system development and, consequently, plant growth was impaired by increasing pressure.

With our experiments, we tried to find a suitable method for measuring the compaction of soil mixtures.

As the best substrates for transplant raising have been prepared of peat all over the word so far, we have chosen two types of peat (highmoor peat and lowmoor peat), as basic material with the aim of making sure the optimal water/air supply of the plants (*Terbe*, 2001). Peats have a high water storing capacity. This is connected with the property that they are capable of considerable changes in volume. The different states of solidity may be characterized by their coherence which is variable, too. This feature is greatly influenced by the origin, the grade of breaking up and by the mineral content of the peat (*Puchner*, 1920).

For improving the structure and the water regime, two kinds of mineral substances – bentonite and zeolite – were mixed to the peats in different ratios. Bentonite is an argillaceous rock, of high montmorillonite content, capable of considerable increase in volume. Zeolite may be characterized by dynamic water absorption of 25–30 per cent because of its molecular pore space (*Zentay & Vitalis*, 1985).

With the aid of an INSTRON type penetrometer (*Zsivánovits* et al., 1997) we were tracing the possible changes caused by watering in the structure of the soil mixtures tested.

Material and method

Transplants in trays are more and more often produced for outdoor vegetable growing. This technology requires proper soil mixtures. In our experiments a number of mixtures of different composition have been tested (*Table 1*).

Table 1 The structural composition of the examined soil mixtures

Treatment	Lowmoor peat V%	Highmoor peat V%	Bentonite V%	Zeolite V%
Control	50	50	0	0
1	47.5	47.5	5	0
2	45	45	10	0
3	42.5	42.5	15	0
4	47.5	47.5	0	5
5	45	45	0	10
6	42.5	42.5	0	15
7	45	45	5	5
8	42.5	42.5	10	5
9	40	40	15	5
10	Commercial mixture of unknown composition			

Seed sowing and transplant raising was made in KITE type Hungarocell trays of 126 and 187 cells, respectively.

The first measuring of soil mixture compactness was made after loose filling (without compression). Among the seeded trays a number of unseeded trays were placed only with soil mixture, and watered like the transplants. The second measuring was performed when germination was completed in the seeded trays.

Instrument: Stable Micro Systems type electronic penetrometer.

Test parameters:

- Test speed: 0.1 mm/s
- Plunger diameter: 25 mm Ø; 490.870 mm^2
- Maximal load: 15 N

Results

The electronic penetrometer makes possible the measuring of the continuous power and of the deformation, thus, the rheogram can be taken *(Figure 1)*. The linear phase of the deformation curve may be well analysed and it is characteristic for the elastic behaviour of the material. The elasticity modulus has been analysed as rheological characteristic *(Figure 2)*.

Discussion

The soil blocks in the trays of 187 cells have the form of truncated pyramids, while those in the trays of 126 cells have the form of truncated cones. In the cells of quadratic base the soil mixture may move towards the sides of the cells if a plunger of 25 mm Ø is used. This can result in measuring errors. The use of a plunger fitting the form of the cells would be practical. The soil blocks of round bottom have the same geometry as the plunger, thus, no volume increase occurred.

Cell depth was 50 mm. The maximal compression distance was 13.488 mm, i.e. 26.98% of cell depth. So it didnt't influence the bottom effect.

Param	No.	Value	Units
Force	1	1.162	N
Distance	1	3.425	mm
Grad.-FD	1:2	0.33441	N\mm
X(FD)-Inter	1:2	-0.049524	mm
Area-FD	1:2	1.699	N mm
Force	2	4.320	N
Distance	2	6.850	mm
Grad.-FD	2:3	0.92206	N\mm
X(FD)-Inter	2:3	2.1649	mm
Area-FD	2:3	8.529	N mm
Force	3	14.925	N
Distance	3	11.415	mm
Grad.-FD	3:4	2.3231	N\mm
X(FD)-Inter	3:4	4.9904	mm
Area-FD	3:4	41.2	N mm

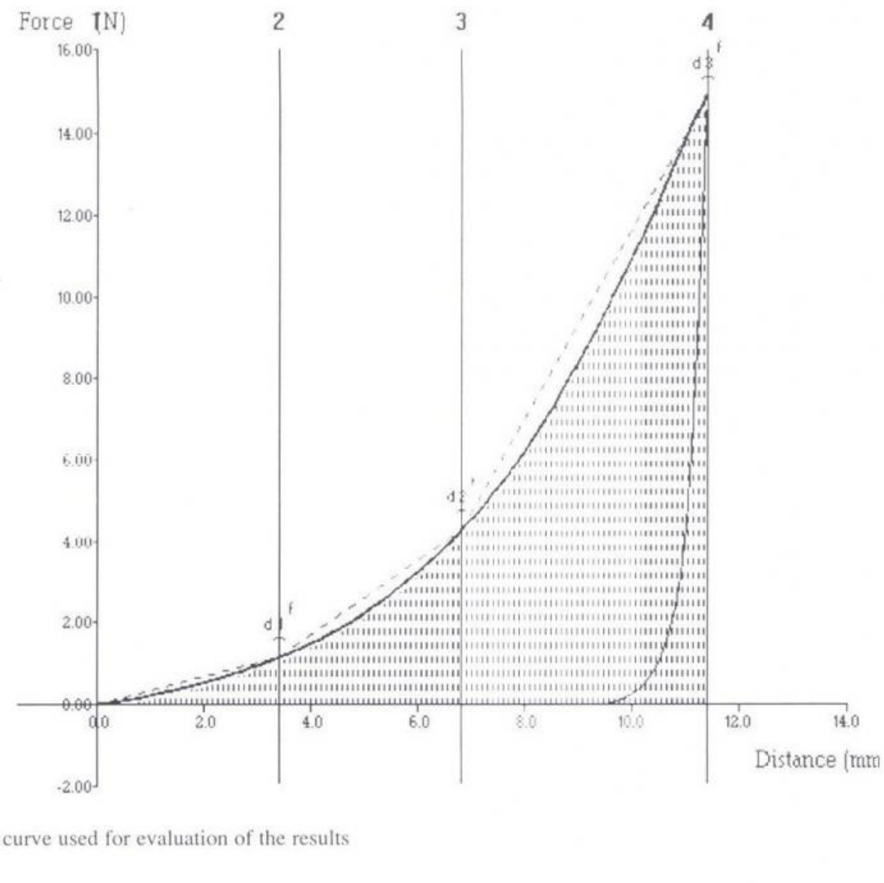

Figure 1 The characteristic parameters of the rheological curve used for evaluation of the results

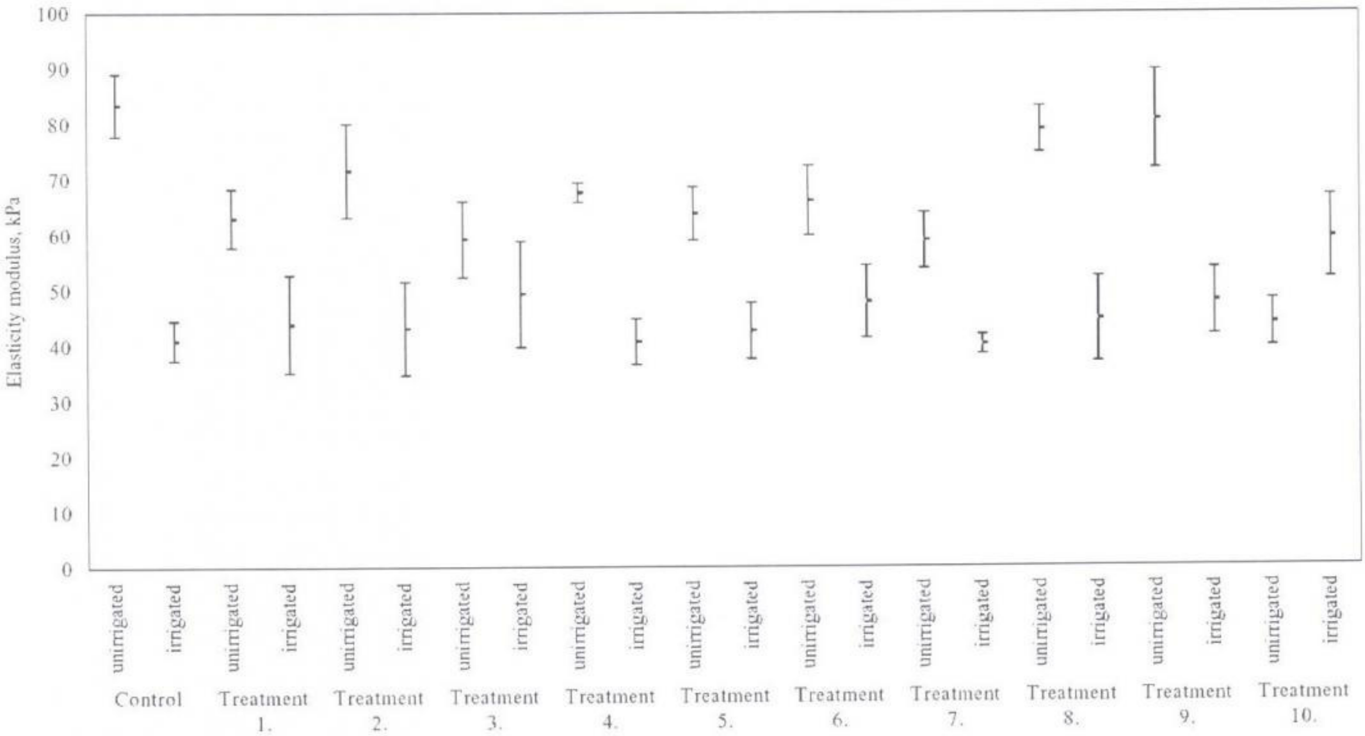

Figure 2 Statistical results of treatments measured in 126 cell trays

In every treatment with mixtures of peat content (Control and treatments 1 to 9), lower forces have been measured in the irrigated trays. In treatment 10 (mixture of unknown composition), we have stated just the opposite effect. There, the elasticity modules showed higher force values (*Figure* 2). In the case of mixtures containing peat this may result from the special structure of peat (*Puchner*, 1920).

The control treatment (that contained peat only) showed the highest force value at filling when the substrate was relatively dry. When small quantities of mineral substances (bentonite, zeolite) were mixed to the peats, the force values decreased.

In wet state, however, the additives increased the force value as compared to the control.

The table penetrometer of Stable Micro Systems type seems to be suitable for measuring the elasticity of nursery plant growing soil mixtures containing peat. The results of the measurings have clearly demonstrated the increase of peat kinds in volume and elasticity, resulting from irrigation. The mineral substances added have reduced the elasticity of peat, together with the increase in the concentration of mixing in.

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