The effect of soil mixtures of different consistence and phosphorus content in tray transplant-growing by lettuce

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Summary: The transplant-growing with root balls gets more and more popular and time to time the only method even in high-quality lettuce transplant-growing. To work out the technology of transplant-growing in trays it was needed to define the accurate physical and chemical consistency of applied soils.

The transplant production in trays could become a good method in field-grown lettuce technologies. The production of transplants of good quality with this technology could be realised only by accurate soil mixtures.

The matter of transplant-growing substrates could be a low-moor turf. Its qualities could be positively influenced by adding minerals like bentonite in amount of 5 (or 10) V%.

To ensure enough phosphorus for the demands of transplants we have to add more fertilisers. The best results by lettuce we got by adding 4 kg/m^3 superphosphate to the soil mixture.

Key words: lettuce-, seedling-, transplant-, tray-, bentonite, phosphor, nutrition, fertilisers, tray transplant production, transplant quality

Introduction

Open field vegetable growing for commercial production in Hungary has an area of about 100 000 ha, the so called intensive production (plastic tunnels, glasshouses, plastic soil mulch, gherkins and tomatoes at strings, melon under plastic tunnel) can be estimated at 7–8000 hectares.

While in open field production direct sowing is dominant (approximately 75–80 000 ha) (*Terbe* et al., 1999), in forcing or in intensive open field cultures the area planted with transplants surpasses 90–95 percent. The transplant demand of the above mentioned area is about 2000–25 000 million per year.

The importance of transplant growing is judged in different ways. In the period of intensive mechanisation it was somewhat less emphasised, ultimately however, with seed prices having considerably increased, it has definitely become crucial.

Transplants are goods that require individual care and mutual trust both from seller and customer. In the long run, only those transplant growing farms will be able to stay on the market that strictly observe technological prescriptions, fulfil phytosanitary regulations and keep improving knowledge and technology.

Issues of substrate structure

A generally accepted wrong way of thinking is that growers judge propagation substrates and soilblocks almost exclusively by the nutrient supply capacity without considering structural and textural aspects. Therefore, it is frequent to see erroneous attempts which try to take into consideration even the most minute particulars in choosing a fertiliser, at the same time are ignorant of structural problems ascribing poor condition, inferior quality exclusively to inadequate nutrient supply or to the defects of the fertilisers mixed in.

By far the most part of soil materials are constituted by silicates providing for the solid structural material, mineral materials which constitute the lesser part of elementary composition have an important role in the nutrient supply of plants (*Forró*, 1999). Often, it is the structural defects of soilblocks that produce stress for the plant. The reason can be the shortage of colloidal clay minerals in the soilblock. In order to eliminate this problem, montmorillonite base clay minerals can be added to the soil mixture (*Hanes*, 2002). Plant growth is equally dependant on soilblock consistency and on the nutrient content of the substrate (*Szalva*, 1963).

Issues of nutrient supply level

On the basis of the analysis of the soil samples collected from horticultural farms, it can be stated that the majority of the problems in transplant production arise from the low phosphorous content of soils.

At the initial stage of plant growth the relative ratio of the nutrients shows a slight difference as compared to mature age plants. The phosphorous uptake of transplants is very high compared to their mass, at the same time, peat soils, but garden moulds and composts also can fix phosphorous in a high degree (*Terbe* in *Mártonffy*, 2001). Unfortunately, growers pay little attention to it and provide phosphorous supplementation for transplant production on the rarest occasions. Phosphorous uptake from soilblocks with often non-optimal temperatures is especially difficult and insufficient.

A frequent reason of phosphorous deficiency is that the peat used as soil for the blocks or pots fixes a considerable part of phosphorous (*Terbe* in *Budai*, 2002). In acid peat aluminium and iron compounds, but excessive lime as well, form insoluble compounds with phosphorous, which are no more available for plants (*Fekete*, 1967). Unavailable phosphorous fixed as aluminium phosphate or iron phosphate can be made soluble and available by liming the soil (*Vaneková*, 1983). It is very important, as it is the roots that require the most phosphorous and during their growth they are in direct contact with phosphorous molecules (*Mengel*, 1982). The fact that rootmasses increase with higher doses of phosphorous can only be demonstrated by weighing the fresh masses of the roots (*Brum*, 1992). If lettuce has no adequate supply of phosphorous in respect of either form or quantity, its growth will slow down significantly, the veins will be discoloured with anthocyanin (*Roorda*, 1981), clorosis will start out from the tip of the leaves and in more serious cases necrosis will occur (*Terbe* et al., 2000).

Material and method

Soil mixtures for transplant growing were made by mixing together different ratios of fen peat and everglade peat. In order to improve soil structure and water retention mixtures of equal portions of the two peat types were enriched with different amounts of bentonite.

Different amounts of superphosphate fertiliser were added to mixtures with equal fen peat and everglade peat portions in order to analyse phosphorous demand.

Tests were located at the Experimental Station of the Faculty of Horticultural Sciences of SZIE in Soroksár, using unheated plastic tunnels.

Seeds of lettuce (variety Ferulia F1) were sown on 04. 04. 2002 into KITE trays with 126 cells. Trays were filled loosely by hand. Each treatment had 6 replications. The detailed composition of the treatments is shown in *Table 1* and *2*. Plants were irrigated according to their demand in morning and evening hours. Prior to sowing seeds had been stored for 48 hours at a temperature of +8 °C. Chemical treatments were applied after sowing against stem rot and two times against insects. Temperatures during the trial did not drop below +15 °C by night, while by day they did not surpassed the critical 40 °C owing to continuous ventilation.

In the trials the following parameters were studied:
germination percentage in the given mixtures
changing of fresh and dry weights of green parts and roots
changing of dry matter contents of green parts and roots
changing of leaf lengths of transplants

Table 1 „A" mixtures, the consistence of different soil mixtures applied in the experiment

Treat-ment	Low-moor turf V%	High-moor turf V%	Bentonit V%	Futor kg/m³	Peat-mix kg/m³	Superphos-phate (18%) kg/m³
Soil mixtures of different consistence						
A1	0	100	0	2.72	2	2
A2	25	75	0	2.25	2	2
A3-K*	50	50	0	1.5	2	2
A4	75	25	0	0.75	2	2
A5	100	0	0	0	2	2
A6	47.5	47.5	5	1.35	2	2
A7	45	45	10	1.275	2	2
A8	42.5	42.5	15	1.2	2	2

*A3-K was the standard control mixture for further comparing

Table 2 „B" mixtures, the phosphorus-content of soil mixtures applied in the experiment

Treat-ment	Low-moor turf V%	High-moor turf V%	Bentonit V%	Futor kg/m³	Peat-mix kg/m³	Superphos-phate (18%) kg/m³
Soil mixtures containing different amount of phosphorus						
B1	50	50	0	1.5	2	0
B2-K*	50	50	0	1.5	2	2
B3	50	50	0	1.5	2	4
B4	50	50	0	1.5	2	6
B5	50	50	0	1.5	2	8
B6	50	50	0	1.5	2	10

*B2-K was the standard control mixture for further comparing

Table 3 Statistical evaluation of tested soil mixtures of different consistence

Parameter	Significance of difference (treatments, and their level of significance in brackets)
Total points of germination	A1–A4 (90%) A1–A5 (90%)
Germination on 2nd day	–
90% germination day	A1–A2 (90%) A1–A4 (95%) A1–A5 (95%)
Stabilization day of germination	A1–A5 (90%) A3–A5 (90%)
Number of transplants possible for sale	A1–A2 (95%) A1–A4 (95%) A1–A5 (95%)
Length of leaves	A1–A5 (95%) A3–A5 (90%) A4–A5 (95%)
Fresh weight of 1 plant	A1–A5 (95%) A3–A5 (90%)
Dry matter content of green parts of plants	–
Fresh weight of 1 plants root system	–
Dry matter content of the roots	A1–A5 (90%)
The ratio of green parts and the root system	A1–A5 (95%)

Table 4 Statistical evaluation of tested soil mixtures of different bentonite content

Parameter	Significance of difference (treatments, and their level of significance in brackets)
Total points of germination	–
Germination on 2nd day	–
90% germination day	–
Stabilization day of germination	–
Number of transplants possible for sale	–
Length of leaves	A3–A7 (90%)
	A3–A8 (95%) A6–A7 (90%) A6–A8 (99%)
Fresh weight of 1 plant	A3–A7 (95%) A3–A8 (99%) A6–A7 (90%) A6–A8 (95%)
Dry matter content of green parts of plants	A6–A8 (95%)
Fresh weight of 1 plants root system	–
Dry matter content of the roots	A3–A7 (95%) A3–A8 (90%) A6–A7 (90%)
The ratio of green parts and the root system	A6–A7 (95%) A6–A8 (99%)

Table 5 Statistical evaluation of tested soil mixtures of different phosphorus content

Parameter	Significance of difference (treatments, and their level of significance in brackets)
Total points of germination	–
Germination on 2nd day	–
90% germination day	–
Stabilization day of germination	B1–B6 (95%) B2–B6 (90%) B4–B6(95%)
Number of transplants possible for sale	–
Length of leaves	B1–B2 (99%) B1–B3 (99%) B1–B4 (99%) B1–B5 (99%) B1–B6 (99%)
Fresh weight of 1 plant	B1–B2 (99%) B1–B3 (99%) B1–B4 (99%) B1–B5 (99%) B1–B6 (99%)
Dry matter content of green parts of plants	–
Fresh weight of 1 plants root system	–
Dry matter content of the roots	–
The ratio of green parts and the root system	B1–B2 (99%) B1–B4 (95%) B1–B5 (95%) B1–B6 (95%)

The statistical evaluation of data utilised variance analysis and comparison by pairs, the results can be seen in *Tables 3, 4* and *5*. With soil mixtures of different structures, relations between mixtures A1–A5 were tested separately, as well as those between A6–A8. Also, statistical data of mixtures with different phosphorous contents were tested separately.

Results and discussion

Treatments A

The most favourable germination dynamics were found in the mixtures with fen peat, bentonite showed no evident influence on the vigour of seed germination. The poorest germination was registered in the mixtures with pure everglade peat *(Figure 1)*. As regards leaf length and fresh weight of transplants, mixtures with everglade peat and those containing 5 V% bentonite seemed to be better. Dry matter content both in the green parts and in the roots of the plants resulted higher in treatments with fen peat and also increased with the V% portion of bentonite *(Figure 3)*. Roots also showed better development in fen peat and bentonite treatments *(Table 3)*.

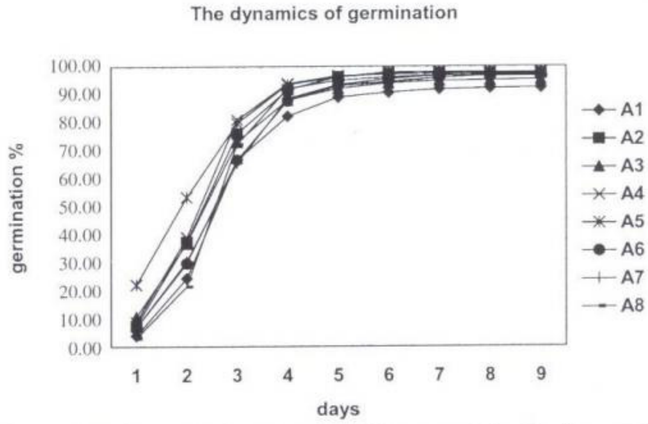

Figure 1 The dynamics of germination of lettuce seed in soil mixtures of different consistence

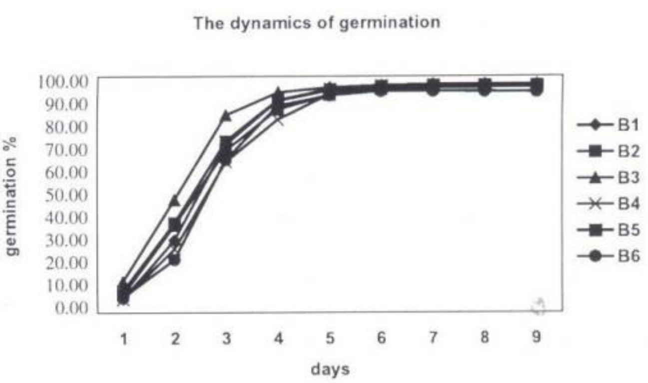

Figure 2 The dynamics of germination of lettuce seed in soil mixtures of different phosphorus content

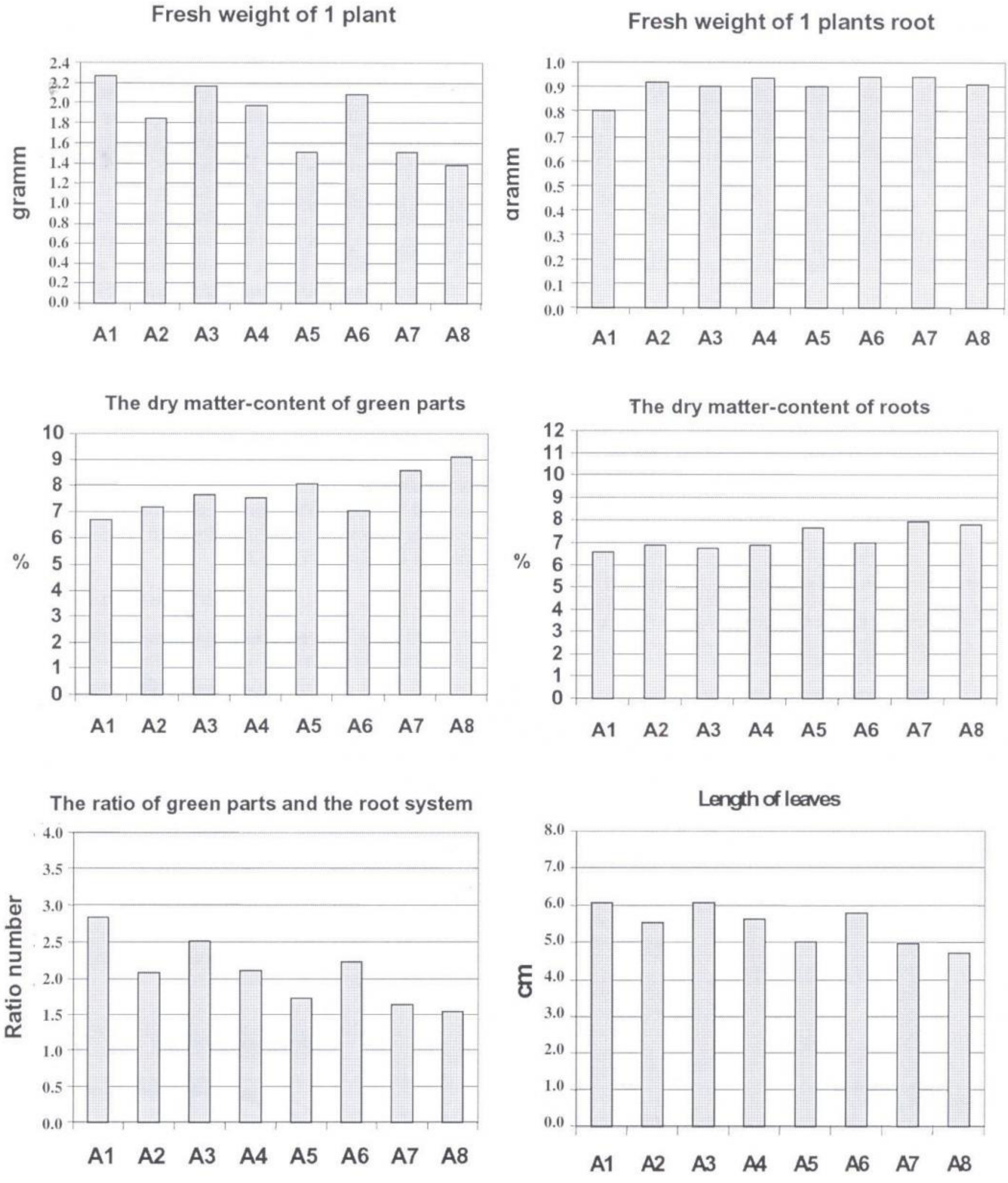

Figure 3 The effect of different soil consistence on development of plants

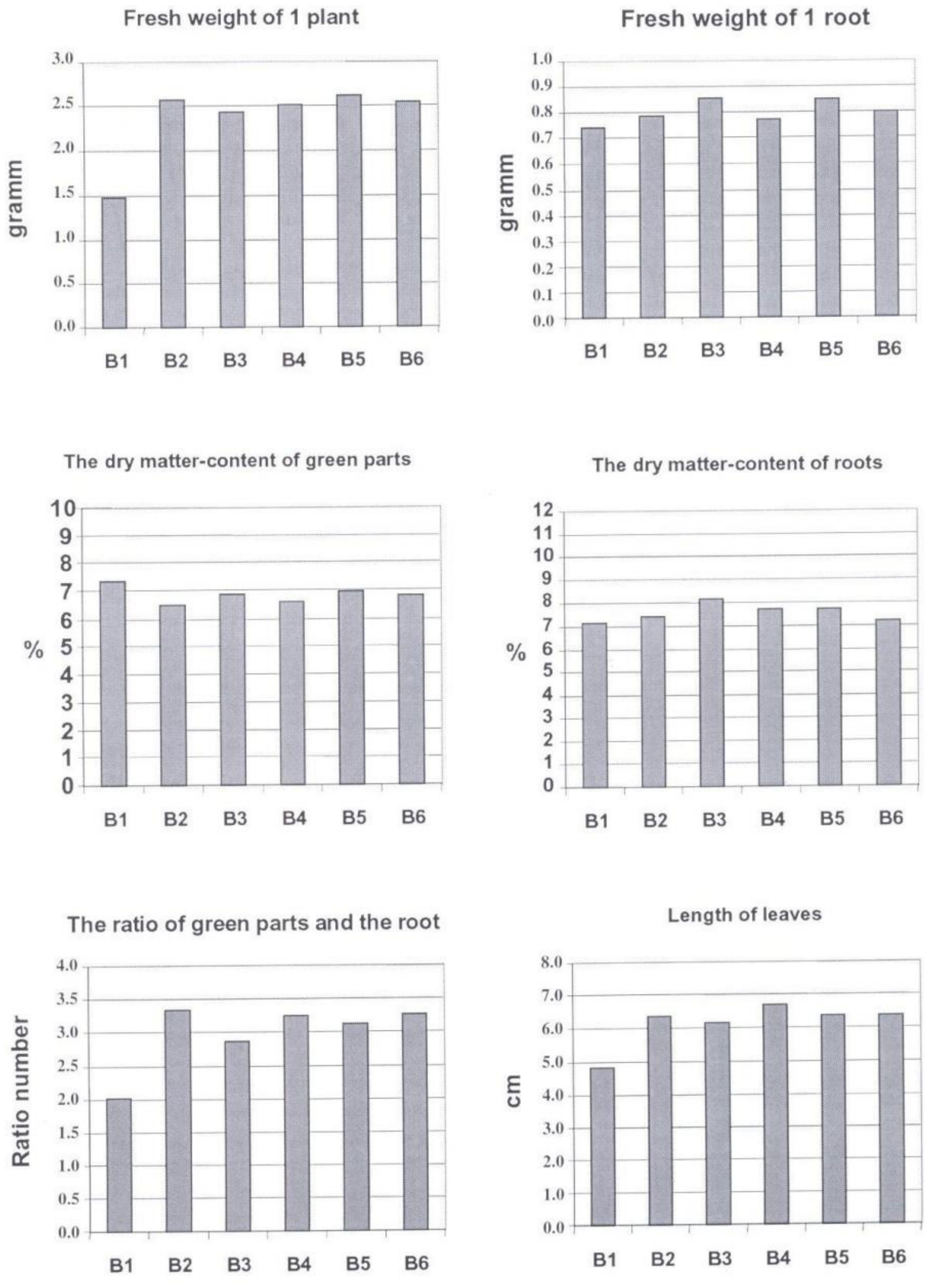

Figure 4 The effect of different phosphor content on development of plants

Treatments B

The most intensive germination was registered in the 4 kg/m^3 treatment, while the least dynamic one in the 10 kg/m^3 treatment (*Fig 2*). Leaf lengths did not show striking variations in the different treatments, only the zero superphosphate treatment was behind the others and fresh transplant weights showed a similar tendency (*Fig 4*). The highest values for the dry matter contents of the green parts of the plants were registered in zero superphosphate treatments (*Fig 4*). Roots had outstanding values both for fresh weight and dry matter in the 4 kg/m^3 treatment (*Fig 4*). All phosphorous surpluses gave better results for green part and root weight proportions.

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