

# Assessment of fruit firmness of pepper using non-destructive physical measurements, in response to different growing and pruning technologies

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**Summary:** The European market demands vegetable products of the highest quality and this commercial quality must be maintained till the goods reach the customer. One of these important quality parameters is the fruit firmness of pepper.

The experiments were aimed at to find out the influence of different growing methods (soil or rockwool-based) and pruning technologies (to 1, 2, 3 or 4 shoots) on the yield and fruit firmness of three pepper varieties (HÓ F1, Kárpia F1 and Pritavit F1) which are common in Hungary. Fruit firmness was measured by the non-destructive impact method.

On the basis of the results, in unheated forcing the pruning to 1, 2 or 3 shoots can be suggested for all three varieties, as well as the utilisation of rockwool in their growing.

The non-destructive impact method has been found suitable for testing the fruit firmness of pepper varieties. In the experiments involving different growing mediums pepper stands were found to show significant differences, however the different pruning methods had no significant influence on fruit firmness.

**Key words:** pepper, pruning, firmness, nondestructive, rockwool

## Introduction

Over the last decades, important changes have taken place in Hungary, the political and economical processes after the collapse of the communist regime have had considerable influence on the life of people who are engaged in vegetable forcing. Changes in ownership (privatisation, the break-up of the cooperatives), increases in energy prices and in the prices of other necessary implements for production are to be mentioned first and foremost. Modifications can be seen in market demands as well. With the appearance of import goods Hungarian growers have to compete also with foreign products, so if they want to remain in competition, they have to offer good quality, appealing and, not in the last place, cheap products all year round.

Recently, more and more practicing growers are curious to know which pruning technology they should apply to the different pepper varieties under the different conditions, what densities are best suited for planting and how many shoots are to be left on the plants.

Besides, in the European market it is important that growers provide very high quality products and products must maintain this quality from the producer to the customer. One of these important quality parameters is firmness.

At the Experimental Station of the Faculty of Horticultural Sciences of SZIE in Soroksár a methodical

experiment was arranged in order to determine how the performance of the stand would respond to pruning to 1, 2, 3 and 4 shoots when grown on soil. In the experiments three Hungarian varieties were tested: HÓ F1, Kárpia F1 and Pritavit F1. Also, the above-mentioned three varieties were tested on rockwool.

An objective of the experiment was to identify the most suitable spacing and pruning method permitting the most profitable growing of the particular variety. Further, the influence of the different pruning (to 1, 2, 3 and 4 shoots) and growing (on soil, on rockwool) methods on fruit firmness was also tested.

## Material and method

Plants were placed in 2002 into the soil of a new bitunnel Filclair plastic house, as well as into rockwool blankets in 4 repetitions. Prior to planting, the soil was analysed with the aim to decide the precise amount of nutrient supply.

For the material of the experiments, three varieties were selected which are widespread in Hungarian production and could be competitive with foreign varieties:

HÓ F1 (white, triangular shape type)

Kárpia F1 (karpia type)

Pritavit F1 (tomato shape type)

**Table 1** Spacing distances used in planting of the different varieties (Soroksár, 2002)

Variety	Pruning method	Row spacing (cm)	Plant distance (cm)	Shoots/m <sup>2</sup>	Plants/m <sup>2</sup>
Hó F1;	1 shoot	80	18	7	7
Kárpia F1;	2 shoots	80	36	7	3.5
Vulkán F1;	3 shoots	80	54	7	2.3
Pritavit F1	4 shoots	80	72	7	1.7

Depending on pruning method, when grown on soil, plants were planted at different distances (*Table 1*) and row spacing was uniformly 80 cm (*Terbe & Gyúros, 1999*).

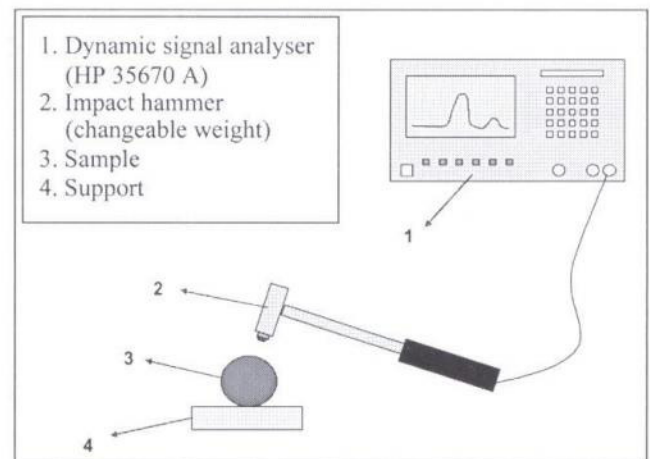
When grown on rockwool, the arrangement was 80+60 x25 cm spacing in twin rows. In this case, the method of pruning was to prune to a single shoot, already successfully tested in practice (*Terbe & Gyúros, 1999*). The pruning of the plants was and an important phase of the experiments it was carried out in the following way (*Gyúros & Tompos, 2001*):

When pruning to a single shoot, after planting the seedlings, on appearance of branching and when shoots were big enough to be seized (3–4 cm), a single shoot was selected (leader) which was then made to grow at a support string. The other shoots were removed from the stem. Later, lateral shoots were pinched back above two leaves (about 15–20 cm). The short 'fruiting shoots' were left untouched. When pruning to two shoots, in a similar manner to pruning to a single shoot, at the first pruning only one shoot was left, then the fruiting surface consisting of two leaders was formed when branching again. Later, the short fruiting shoots were left, but the lateral shoots were entirely pinched from the stem. The short fruiting shoots are needed to create an adequate assimilation surface. If lateral shoots were left, leaf area would increase excessively and the stand would become tangled and uncontrollable. When pruning to three shoots, plants were pruned after planting depending on the number of branches. In the case of three branches all three branches were left and the final shoot system was formed from them. In the case of two branches the third leader was selected from the second branching level. The method described for the technology for the two shoots applies also to this case, i.e. lateral shoots must be entirely pinched from the stem and the short fruiting shoots must be left. When creating a fruiting surface with four shoots, two of the first branches were left, which means four branches on the second branching level. These four shoots are then made to grow as leaders. Pruning at fruiting age is the same as described for the technologies for two or three shoots.

Picking and measuring was usually carried out in morning hours. Fruits were picked into plastic buckets, then stored in labelled plastic sacks until measuring. Pritavit F1 and Kárpia F1 varieties were harvested in biological maturity, Hó F1 in economical maturity. After picking measuring was started already on the very same day. Fruit mass and number were determined at the Experimental

Station in Soroksár then laboratory measurements followed. These were carried out on the same day at the Department of Physics and Control of the Faculty of Food Science of SZIE. During the growing period two samplings were made. Samples were unsorted and homogenous sampling was carried out.

The dynamic impact method (*Figure 1*) was used for the measurements (*Felföldi & Ignát, 1999, Felföldi & Fekete, 2000*). The instrument includes the following parts: impact hammer (changeable weight), electronic signal converter and dynamic signal analyser (HP 35670 A). An accelerometer is built into the impact hammer. The two measurement points selected for each sample were at the largest diameter and at the midpoint of the length of the pepper. The signal analyser displayed the accelerometer voltage as a function of time. The time and voltage differences between the zero and maximum acceleration points of each trace were recorded. The firmness of the pepper (as determined in previous studies) was defined by the dynamic factor  $D_d=1/\Delta T^2$ , where  $\Delta T$  is the time difference between the zero and maximum points of the signal in milliseconds.



**Figure 1** Arrangement of the dynamic impact measuring system

## Results and discussion

Yield data of the three varieties are illustrated in *Table 2*, where yield results of the four pruning methods and those of the stand grown on rockwool are shown, expressed in fruit mass and number.

**Table 2** Influence of pruning and growing methods on the yields of the pepper varieties

	Yield averages of Hó F1 (kg/m <sup>2</sup> )	Yield averages of Kárpia F1 (kg/m <sup>2</sup> )	Yield averages of Pritavit F1 (kg/m <sup>2</sup> )
Soil 1 shoot	10.13	10.59	10.26
Soil 2 shoots	10.33	10.01	10.45
Soil 3 shoots	10.15	10.7	10.17
Soil 4 shoots	8.47	8.3	9.14
Rockwool			
1 shoot	18.38	13.98	13.87



In the case of the variety H6 F1 yield averages in response to pruning to one, two and three shoots can be considered identical both in terms of fruit mass and number. The lowest yield was registered for the method for four shoots (8.47 kg/m<sup>2</sup>). Comparing rockwool-based growing with traditional soil-based forcing it can be clearly seen that the yields of the plants grown with this method (18.38 kg/m<sup>2</sup>) are 80% higher than the results registered on soil.

In the case of the variety Kárpia F1 results were very similar to those above. When pruning to 1, 2 and 3 shoots yield results did not differ. No difference can be detected between them. Yield results of the fourth treatment are again inferior to the other three. Comparing the growing mediums it can be stated that the yield results measured on rockwool are more than 32% higher than those of the plants grown on soil.

As regards yield results of the variety Pritavit F1 the highest values for fruit mass and fruit number per square meter were measured when having pruned to 1, 2 and 3 shoots. The technology for four shoots is again inferior to the others. Similarly to the former cases, the biggest yields were harvested from the stand grown on rockwool, which meant 35% yield increase.

Figures 2–4 present the effects of the pruning methods on the firmness of the peppers. The same results were observed for the 3 varieties and the four pruning techniques. Discriminant analysis (SPSS) did not find any differences in firmness attributable to the pruning techniques.

Figures 5–7 present the effects of the growing methods (on soil and rockwool). The results of these experiments were also analysed by SPSS. Discriminant analysis successfully identified the growing conditions (soil or rockwool) for more than 80% of the peppers. This result was observed for every variety of pepper. The best separation was achieved in the case of Pritavit F1. Analysis of variance showed a significant difference (95%) between the firmness of the peppers that were grown in soil and in rockwool. Analysis of samples from the second harvest confirmed results determined from the earlier harvested samples. Based on this experiment, it can be said that the peppers that were grown on rockwool had firmer texture than the peppers grown on soil.

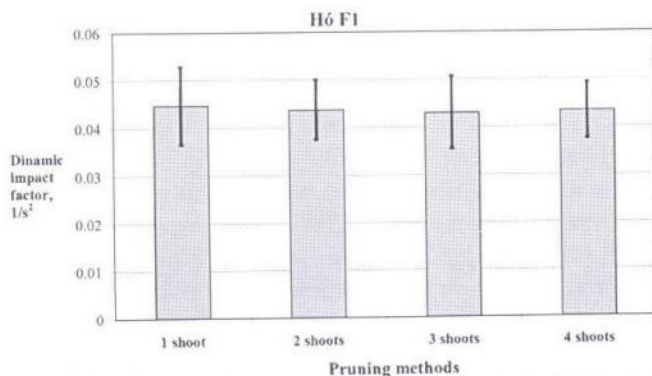


Figure 2 Influence of the different pruning methods on the fruit firmness of the pepper variety H6 F1

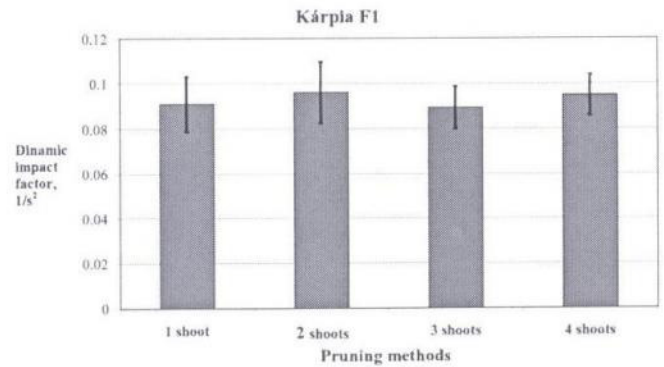


Figure 3 Influence of the different pruning methods on the fruit firmness of the pepper variety Kárpia F1

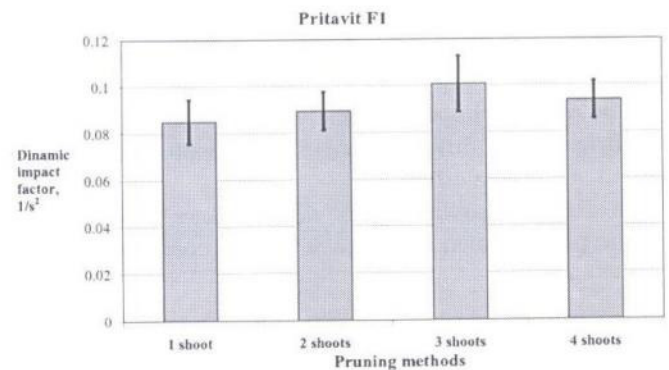


Figure 4 Influence of the different pruning methods on the fruit firmness of the pepper variety Pritavit F1

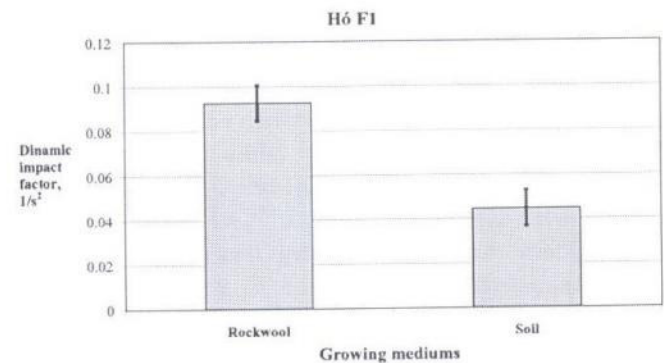


Figure 5 Influence of the growing mediums on the fruit firmness of the pepper variety H6 F1 (1 shoot pruning)

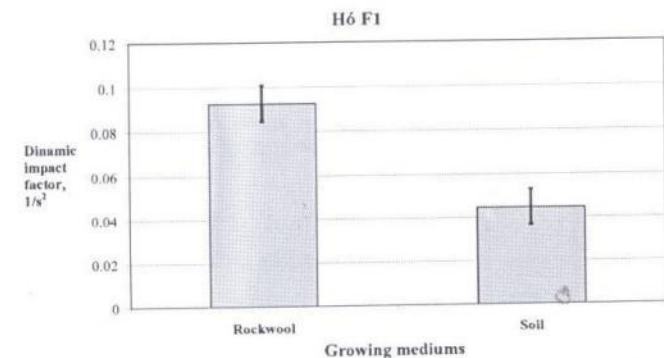


Figure 6 Influence of the growing mediums on the fruit firmness of the pepper variety Kárpia F1 (1 shoot pruning)

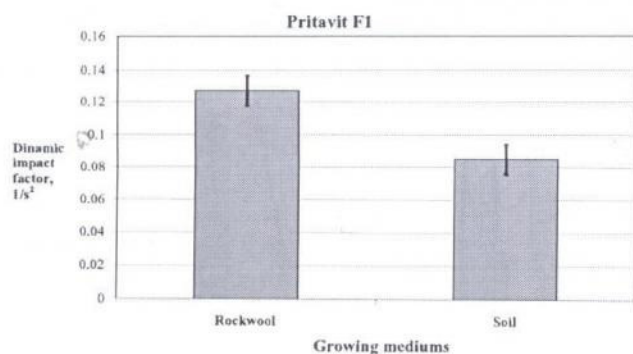


Figure 7 Influence of the growing mediums on the fruit firmness of the pepper variety Pritavit F1 (1 shoot pruning)

## Conclusions

The dynamic impact method was suitable for measuring the firmness of different varieties of peppers that were treated and grown differently.

In all three cases the highest yield averages were obtained for the plants grown on rockwool and it confirms the data

from the literature and the experiences from practice. When grown on soil (in the case of each variety) the lowest yield averages were obtained for the pruning technology for four shoots. In the case of pruning to 1, 2 and 3 shoots no significant difference was recorded between yield averages.

On the basis of the results, in unheated forcing the pruning to 1, 2 or 3 shoots can be suggested for all three varieties, as well as the utilisation of rockwool in their growing.

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