Comparison of light yellow fleshed pepper varieties grown on rockwool under unheated forcing conditions

Tompos D. and Gyúrós J. Jr.

Budapest University of Economic Sciences and Public Administration
Faculty of Horticultural Sciences, Department of Vegetable- and Mushroom Growing
H-1118 Budapest, Ménesi út 44, Tel.:0036-1-372-6225, <ratm@freemail.hu>

Summary: Experiments are going on all over the world assisting the joint effort of researchers and practicing specialists to identify the methods which can help either in the reduction of production costs or in the increase of yields.
The task of the growers is to make profitable use of the forcing facilities and to satisfy market demands at an acceptable price by means of improving production technology and applying new scientific, technological and technical information.
For the last few years, rockwool based forcing has been gaining in importance. The subject of our scientific work was the analysis of an important question of this technological variant, the selection of the variety. Besides, we also tried to identify the most suitable pruning technology for the varieties studied.
In Hungary, the highest demand is commonly known to be for the light yellow fleshed varieties which are suitable for stuffed dishes. In the future, due to their special quality and appearance, as well as to the Hungaricum character, they could become important export goods on the European Union market. It was within this variety type that comparison between varieties already common in production (Hó F_1, HRF F_1, Danubia F_1) was carried out, trying to get an answer to the question which of the three varieties could be produced with the greatest success. Considering the quantitative and qualitative indicators, it was Hó F_1 that proved the best out of the three varieties tested under unheated forcing on rockwool. It excelled the other two varieties both in quality and in average fruit weight, preserving this advantage until the end of the growing period.

Key words: pepper, rockwool, pruning

Introduction

Among the plants grown in forcing houses in Hungary, the most important one is pepper, giving 50% of the total value of production. Now, about 2000-2500 hectares are involved in pepper forcing. As a great deal of labour is required, production is carried out chiefly by small enterprises and on family farms (*Tégla*, 2003). The size of the majority of the farms that produce profitably ranges between 1000 m^2 and 3000 m^2.

Pepper consumption in the European Union is on a sharp increase and this trend is expected to remain unchanged for the next few years. The contribution of Hungary is only 1%. Among the member states Holland and Spain are net exporters, i.e. more pepper is exported than bought (*Deme*, 2003).

With the appearance of globalisation and new consumption habits, products, such as white-fleshed pepper, formerly present only on the East-European markets, have become popular on European markets. It is also of great importance that vegetable production is not tied to quotas in the European Union and this is the reason why white-fleshed pepper may acquire more and more importance in the exports with its *hungaricum*-like particular appearance and quality. The increase of the exports, however, requires an adequate background of producers, quality assurance and inventing marketing activities.

The structure of production will also undergo changes. As heating costs being high, very early and early production will lose ground or only the more powerful growers already existing (e.g. Árpád Agrár Share Company) will be able to go on utilising this production technology. High levels of heating will be supportable chiefly where it will be possible to use cheap natural energy sources (e.g. thermal water) as well. Soil based production is also losing ground due to the increasing level of soil infection and the consequent decreases in yield levels. As a result, rockwool-based growing area will see further increases. New technologies and the rising of competition will set further tasks to Hungarian horticulturists. They will have to make decisions that will decide production throughout the whole year.

One of the most difficult questions of rockwool based pepper forcing is the selection of the variety. Varieties are chosen on various points of view, but the most important point is always the requirement of the market. The selection of the suitable growing period is determined considering the size of available growing facilities and the amount of investment available (*Zatykó*, 2000). Different growing periods permit successful production to different varieties, as corresponding to the specific environmental requirements changing from variety to variety.

Material and method

In the experiments set up in 2003, three white fleshed pepper varieties commonly used in Hungary, were tested with three pruning technologies in unheated forcing on rockwool. The objective was to know which varieties could be forced successfully under these conditions and with which pruning technology.

The experiments were carried out at the Experimental Farm of the Budapest University of Economic Sciences and Public Administration at Soroksár. Plants were planted out on rockwool blankets in an aisle of a 1500 m^2 FILCLAR plastic block. The facility was 52 meter long and 9.6 m wide with 3.75 meter gutter height.

Three indeterminate varieties (Hó F_1, HRF F_1, Bajnok F_1) had been chosen for the subject of the experiments. These varieties are commonly used in Hungary and may be competitive with the foreign varieties.

The necessary transplant number had been calculated, sowing took place on March 6, 2003. Seeds were sown in *Grodan AO 25/40* growing blocks and covered with vermiculite. The trays were then placed under an energy screen where plants were kept by night at a temperature of approximately 18 °C and by day at a temperature of 25 °C. Pricking out took place on March 9, 2003 in 8.5×8.5×7.5 cm large *Grodan 5,4 G* starter blocks. Seedlings pricked out were placed in propagation boxes, close to one another. On April 9, 2003 transplants were transferred into the *Filclar* plastic block and the growing blocks were placed apart because plant leaves were already touching. Transplanting took place on the April 29. Plants were spaced in twin rows in the following pattern in accordance with the type of pruning *(Table 1)*:

Table 1 Spacing distances used in planting of the different varieties (Soroksár, 2003)

Varieties	Pruning method	Row spacing (cm)	Plant distance (cm)	Stems/m^2	Plants/m^2
HÓ F1	1 stem	80+60	25	5.7	5.7
HRF F1	2 stems	80+60	33	8.6	4.3
DANUBIA F1	3 stems	80+60	40	10.8	3.6

Pruning was an important moment of the experiment and it was carried out as follows:

Three different pruning technologies were applied. In the first treatment plants were pruned to a single stem, in the second to two stems and in the third to three stems. Each treatment was carried out in four repetitions:

Single stem pruning: after planting the seedlings, on the first 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 (Gyúrós, 1996). 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 (Tóth & Fehér, 2001).

Double stem pruning: in a similar manner to the single stem pruning, 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 removed from the stem. The short fruiting shoots are needed to develop an adequate assimilation surface. If lateral shoots were left, leaf area would increase excessively and the stand would become tangled and uncontrollable (*Terbe & Gyúrós*, 1999).

Three-stem pruning: 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 having originally only two branches, the third leader was selected from the second branching level. The method described for the double stem technology applies also to this case, i.e. lateral shoots must be entirely removed from the stem and the short fruiting shoots must be left.

Mature fruits that had a size, colour and firmness that were characteristic of the variety were picked continuously every 10–14 days during the growing period (harvest of all three varieties took place at the same time) (*Szabó*, 2000). 10 pickings were carried out in all, the last one falling on the Oktober 22.

Harvesting was done each time in the early morning. Measurements were made for overall yield weights and then, after grading, for the weights of the different classes. Four classes were formed: extra quality, 1st class, 2nd class, inferior quality (sunburnt and deformed fruits, undersized fruits)

In the evaluation of results, yields were determined and expressed as yield per area, and yield data averages were calculated. Besides, it was considered very important to know the yield per plant, since the real performance of the plants can be decided only with their help.

Results obtained were analysed by SPSS software.

Results

Results calculated for the overall yields of the varieties

According to the Table 2, 3 and 4, it is stated that in 2003 the highest yield was registered for the variety HÓ F_1 with the single stem training. However, variety analysis could not reveal any significant difference between the single stem and the two stem pruning method. Considering single plant specific indicators, it was the three stem plants that had the highest number of fruits picked and this number decreased with the decrease of fruiting stems. Average fruit weights did not differ from the characteristic values of the varieties as a result of either of the treatments *(Table 2)*.

According to the results of 2003, yield averages of the variety HRF F_1 were almost the same in the three treatments and no significant difference could be found between them. The lowest yield of this variety was again registered for the three-stem pruning. Treatments had no influence on average fruit weights *(Table 3)*.

Table 2 Yield results of the variety Hó F_1 (Soroksár, 2003)

	kg/m²	fruits/m²	kg/plant	fruits/plant	Average fruit weight (g)
1 stem	20.62	203.87	3.64	35.68	101.14
2 stems	20.13	194.82	4.70	45.46	103.34
3 stems	18.84	181.42	5.27	50.80	103.84

Table 3 Yield results of the variety HRF F_1 (Soroksár, 2003)

	kg/m²	fruits/m²	kg/plant	fruits/plant	Average fruit weight (g)
1 stem	16.84	184.05	2.95	32.21	91.59
2 stems	17.06	188.63	3.98	44.01	90.40
3 stems	16.26	185.88	4.55	52.05	87.55

Results were different in the case of the variety Danubia F_1. This time, the highest yield average was produced by the two-stem pruning, both in terms of yield weight and fruit number. The lowest yield was again encountered with the three-stem pruning *(Table 4)*.

Table 4 Yield results of the variety Danubia F_1 (Soroksár 2003)

	kg/m²	fruits/m²	kg/plant	fruits/plant	Average fruit weight (g)
1 stem	16.34	200.53	3.09	37.95	81.59
2 stems	17.07	205.24	3.98	47.89	83.25
3 stems	15.81	193.25	4.37	54.11	81.75

Fruit distribution according to quality

Studying the percentage distribution between the different classes in the case of the variety Hó F_1, variety analysis at 95% probability did not show any difference between the pruning methods. The rate of the extra quality fruits was over 10% in each case and that of the I. class fruits was over 40%. The rate of the inferior quality fruits was under the acceptable limit with all three treatments *(Table 5)*.

Table 5 Fruit distribution according to quality. Variety Hó F_1 (Soroksár, 2003)

Pruning technique	Extra quality (%)	I. class (%)	II. class (%)	Inferior quality (%)
1 stem	10.97	42.77	33.43	12.82
2 stems	12.88	44.84	29.07	13.21
3 stems	10.52	46.23	32.06	11.09

Results showed a similar picture in the case of the variety HRF F_1. The rate of the extra and first class quality fruits, however, was lower than with the variety Hó F_1. This time again, no significant difference could be found between the treatments. The lowest values were registered for the three-stem pruning *(Table 6)*.

Table 6 Fruit distribution according to quality. Variety HRF F_1 (Soroksár, 2003)

Pruning technique	Extra quality (%)	I. class (%)	II. class (%)	Inferior quality (%)
1 stem	6.49	39.32	40.14	14.05
2 stems	5.81	40.24	41.27	12.68
3 stems	3.35	38.09	43.92	14.64

Table 7 Fruit distribution according to quality. Variety Danubia F_1 (Soroksár, 2003)

Pruning technique	Extra quality (%)	I. class (%)	II. class (%)	Inferior quality (%)
1 stem	1.86	30.11	52.11	15.92
2 stems	1.35	33.07	51.67	13.91
3 stems	0.86	30.74	55.75	12.65

From the data in *Table 7*, it is obvious that the variety Danubia F1 was inferior to the other two in terms of yield quality. It was this variety that had the lowest rate of extra and first class quality fruits. Neither this time was it possible to find any significant difference between the three pruning methods. With this variety again, the lower rate of extra and first class quality fruits was registered for the three-stem pruning.

Conclusions

Of the three varieties tested in unheated rockwool based forcing, the best was Hó F_1, considering the quantitative and qualitative indicators. It excelled over the varieties tested both in terms of quality and average fruit weight, preserving this characteristic until the end of the growing period. It is true, though, that Hó F_1 showed much more sensitive responses to environmental changes than the other varieties. In accordance with the results obtained, the two-stem pruning is recommended principally from economic reasons, as transplant growing costs per square meter are 30-35% lower compared to the single stem pruning.

Yield results of the variety HRF F1 are acceptable, though somewhat behind those described in connection with the previous variety. The even and reliable fruiting pattern that characterises the variety was observed in all three treatments. The best results were registered for the two-stem pruning, therefore, again, this pruning technology is recommended for this variety in the first place.

On the basis of the results obtained for the variety Danubia F_1, it is evident that, again, the double stem cultivation proved the best for this variety. Fruit quality, however, showed strong variations during the growing season. The plant was strongly generative, with abundant fruit setting and small fruits, having a tendency to develop tiny fruits. Therefore, it is recommended for early season production.

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