

# Cold Stored Tray Plants in Open Field Cultivation of Strawberries

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## Summary

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Cold stored strawberry tray plants (TP) are becoming a more popular plant type in soilless strawberry production all over Europe. Due to their higher yield potential, TP plants are suitable for fruit production out of the main season. In this way, the strawberry production is extended to the summer period when the demand for fresh fruit exists.

Research was carried out in 2003 and 2004 in the open field near Zagreb. Two types of plant material (TP and 'frigo' - F) of late ripening cv. Raurica, were included in the trial. The plants were planted at the end of June 2003, in the period after the main season of the strawberry production in Croatia. White plastic mulch was used to decrease the heating caused by high summer temperatures. The differences between TP and frigo plants in the dynamics of fruit ripening, average weight of the fruit and total yield were investigated in this research.

It was found that cold stored tray plants had significantly more fruits and total yield per plant comparing to the frigo plants in the first year of the investigation. No significant difference of researched parameters between TP and F plants was noticed in the second year.

Cold stored tray plants in the open field showed great potential and they should be widely used in production of strawberry fruits out of season.

## Key words

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*Fragaria x ananassa* Duch.; yield; frigo plants

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## Introduction

Intensive strawberry production in Croatia is based on the use of cold stored runner plants ('frigo' - F) which are planted in open fields. Planting of these plants is carried out during the summer season in double rows using black plastic mulch and a drip - fertigation system. Production is based mainly on short day varieties (Marmolada, Miss, Madeleine, Clery, Maya, Albe etc.). In such a production system the strawberry plants bear fruit in the spring of the following year. Overproduction of strawberries at the end of May and at the beginning of June decreases the price, while a deficit in supply occurs during the summer season. The interest for producers and the market is how to expand the production season and how to respond to increased demand during the tourist season.

The choice of cold stored plant types which are used in production out of season, have high influence on the yield and harvest during the summer period (Duralija et al., 2006). It is known that cold stored tray plants (TP) have been produced since the beginning of the 1990s (Lieten, 2002). Recently, cold stored tray plants have played a more significant role in out of season strawberry production in the Republic of Croatia. This type of plant is particularly used in soilless production systems (Duralija, et al., 2004).

TP have many advantages compared to frigo plants. For example, the plants can have less disease, higher yielding potential and a higher percentage of big fruit (Lieten, 2000.). In Northern Europe, the strawberry harvest season can be earlier or later compared to normal open field production. The supply of fruit is extended over a longer period, if cold stored tray plants are used (Hoppula and Karhu, 2006). Wide use of TP in production in open fields and in greenhouses is expected (Durner et al., 2002).

The objective of this study is to get insight into the performance and the yielding potential of TP in open field production compared to frigo plants.

## Material and methods

The short day variety 'Raurica' was included in the experiment and planted in the open field at the end of June 2003. The production system was a single row with white plastic mulch. The distance between plants within the rows was 0.2 m, while the distance between rows was 1.2 m (4 plants m<sup>-2</sup>) with included fertigation 'drop by drop'. Two plant types (PT) were used: cold stored tray plants (TP) and frigo plants (F). Fifty plants of each type were planted in five repetitions of 10 plants each in randomized complete block design (RBCD). The research was carried out in Lužan (near Zagreb, 45°52'N,

16°12' E). The fruit was harvested from the same plants two to three times per week in 2003 and 2004. The total yield (Y) and average weight of fruits was measured on each harvest date (HD). Analysis of variance (ANOVA) were performed on all data using SAS Release, ver. 8.0 software package.

## Results and discussion

Since the harvest dates were different in 2003 and 2004 (Figs. 1-6), this factor was omitted from the ANOVA of cumulative data (Table 1). The year had significant influence to all measured parameters (Table 1). TP showed tendency of higher productivity over two seasons. However, due to the high variation in number of fruits and fruit

Table 1.  
Cumulative results of performance of strawberry plants cv. Raurica grown over two seasons in open field

Source	Number of fruits per plant	Average fruit weight (g)	Yield (g/plant)
Year (Y)	***	***	***
Plant Type (PT)	n.s.	n.s.	n.s.
Y×PT	n.s.	**	n.s.
2003	28±7 <sup>x</sup>	8.0±0.7	229.8±76.7
2004	67±12 <sup>x</sup>	16.9±1.0	1118.7±179.3
Frigo (F)	87±16 <sup>x</sup>	14.8±0.2	1280.7±229.2
Tray Plant (TP)	103±6 <sup>x</sup>	13.7±0.5	1415.1±113.7

The values are mean ± SD; n.s. - non-significant, \*\* - significant at  $P \leq 0.01$ , \*\*\* - significant at  $P \leq 0.001$ ; <sup>x</sup> - values are rounded to whole number

weight for this type of plant (Table 1), they were not significantly different in comparison to F plants.

Annual analyses showed different situation (Table 2). Number of fruits and fruit weight were higher in 2004, which resulted with higher yield that year (Table 2). Interaction year × plant type was significant only for average fruit weight. TP had significantly higher production in comparison to F plants in 2003 (Table 2), but this was no longer significant in 2004.

The harvest date had significant influence on all measured parameters during both years of research (Table 2). TP plants in 2003 had more fruits, higher average fruit weight and higher average yield in comparison with F plants. The positive effect of TP disappeared during 2004, and no significant differences in measured parameters were observed (Table 2). Plant type and harvest date interaction was not significant for average fruit weight in 2003 and for all observed parameters in 2004.

Table 2.  
Performance of strawberry plants cv. Raurica in 2003 and 2004

Source of variability	Year 2003			Year 2004		
	Number of fruits per plant	Average fruit weight (g)	Yield (g/plant)	Number of fruits per plant	Average fruit weight (g)	Yield (g/plant)
Harvest date (HD)	***	***	***	***	***	***
Plant Type (PT)	***	***	***	n.s.	n.s.	n.s.
HD×PT	*	n.s.	*	n.s.	n.s.	n.s.
Frigo (F)	22±2 <sup>x</sup>	7.3±0.3	158.2±17.8	65±2 <sup>x</sup>	17.43±1.0	1122.2±243.3
Tray Plant (TP)	35±2 <sup>x</sup>	8.6±0.2	352±15.3	68±6 <sup>x</sup>	16.44±0.8	1113.8±114.4

The values are mean ± SD; n.s. – non-significant, \* – significant at  $P \leq 0.05$ , \*\*\* – significant at  $P \leq 0.001$ ;

<sup>x</sup> – values are rounded to whole number

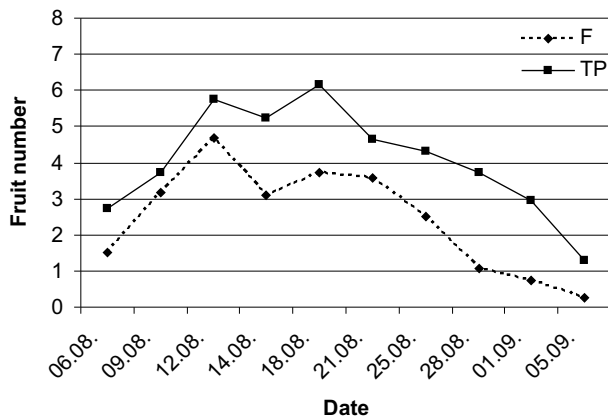


Figure 1.  
Number of harvested fruits per plant in different harvest times during the season 2003

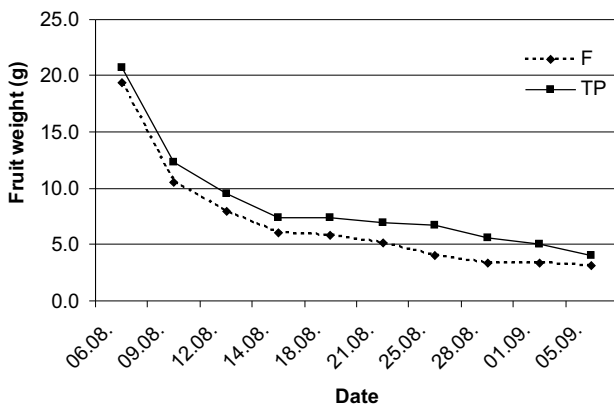


Figure 2.  
Average fruit weight during harvest season 2003

The number of fruits developed on TP plants was significantly higher in comparison to F plants in 2003 and this tendency was noticed in all ten harvests (Figure 1). TP plants had higher average fruit weight in comparison to F plants (Figure 2). Since the total yield is a product

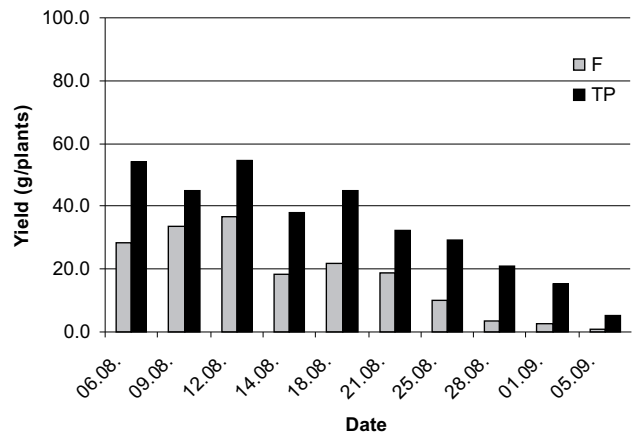


Figure 3.  
Harvest dynamics of fruits on different types of strawberry plants 'Raurica' in year 2003

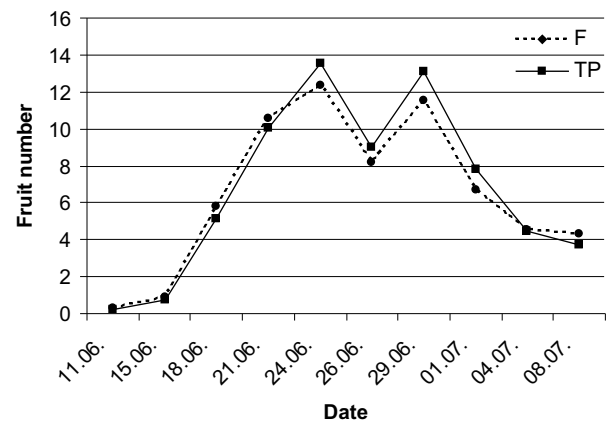


Figure 4.  
Number of harvested fruits per plant in different harvest times during the season 2004

of fruits quantity and their average weight, yields of TP plants were significantly higher comparing to F plants during all ten harvests in 2003 (Figure 3). Strawberry cultivation results obtained in open fields corroborate those obtained in greenhouses (Lieten, 2002).

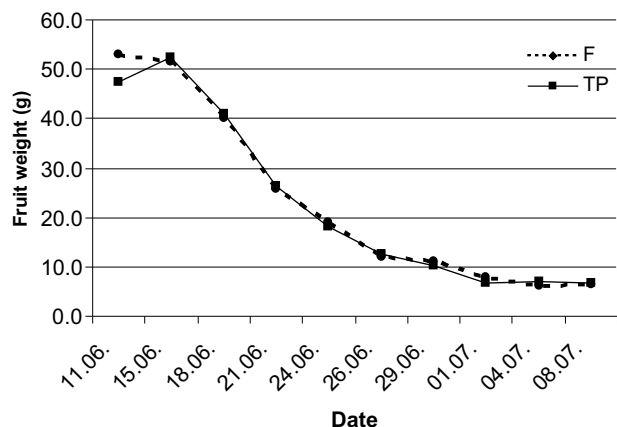


Figure 5.  
Average fruit weight during harvest season 2004.

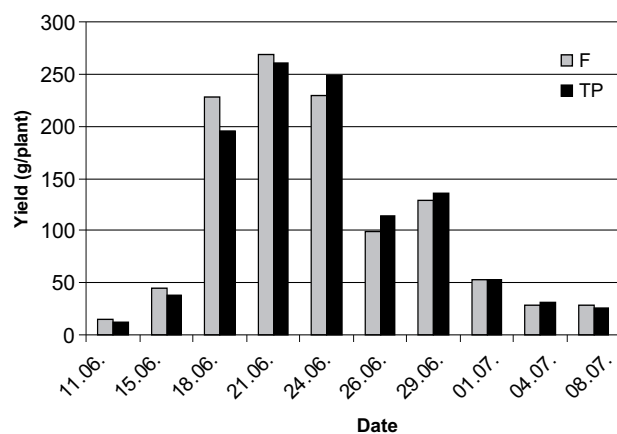


Figure 6.  
Harvest dynamics of fruits on different types of strawberry plants 'Raurica' in year 2004

No significant differences were observed in any measured parameters of different plant types in 2004 (Figures 4, 5 and 6).

### Conclusions

After comparing TP and F plants of cv. Raurica using white plastic mulch, it is concluded that TP plants have a positive effect on yield only in the first year of production. In the second year of the experiment, there was no significant yield increase in comparison to F plants. Overall the production of cold stored tray plants showed a strong trend of yield increase. It is evident that this plant type should be more widely used in out-of-season production.

### References

- Duralija B., Čmelik Z., Miličević T., Njavro M., Šimon S. 2004. Ohlađena kontejnerska sadnica – novost u proizvodnji jagoda. *Sjemenarstvo* 21:267-273
- Duralija B., Čmelik Z., Družić Orlić J., Miličević T. 2006. The Effect of Planting System on Strawberry Yield Grown Out of Season. *Acta Horticulturae* 708:89-92
- Durner E. F., Poling E. B., Maas J. L. 2002. Recent Advances in Strawberry Plug Transplant Technology. *HortTechnology* 12(4):545-550
- Hoppula K. B., Karhu S. T. 2006. Strawberry fruit quality responses to the production environment. *Journal of Food, Agriculture & Environment* 4(1):166-170
- Lieten P. 2000. Recent Advances in Strawberry Plug Transplant Technology. *Acta Horticulturae* 513:383-388
- Lieten P. 2002. The Use of Cold Stored Material in Central Europe. *Acta Horticulturae* 567:553-560