Covered soilless strawberry production in the field by raised substrate beds

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Abstract

Markets are forcing higher demands on fruit quality. Protected strawberry cultivation helps to meet such demands and is accepted as a typical future production system. Not only is labour comfort, harvest reliability and fruit quality improved, but infection pressure from pathogens such as *botrytis* is reduced. Cost on the other hand is an impediment to the widespread adoption of tunnelled production in soil.

In 2006 pcfruit started looking for a way to reduce the annual costs associated with constructing tunnels. Successive strawberry crops in one season in the same tunnel would be rewarding provided there was no risk of infection by nematodes or soil borne diseases. Soil fumigation could alleviate such risks however besides being expensive it is environmentally harmful and the future of the use of soil disinfectants is uncertain.

One way to avoid soil health problems was to move to a substrate system on raised gutters (table-top system). Table-top production offered permanent protection and facilitated multiple in-situ crops per year. Table-top production however, is expensive and labour-intensive. Another option for the soilless cultivation of strawberries is the 'raised substrate bed' developed in Limburg, Belgium. In this system, high beds are formed in the soil and then covered with an impermeable weed mat. A trough is formed along the ridge and filled with a substrate, usually peat. Low investment, simplicity and the possibility to use poorer soils are just a few of its advantages.

Ten years of research on the 'raised substrate bed' has demonstrated its potential. The cropping of both short-day and day neutral varieties has been explored. Mulch type, soil heating, multi-cropping and sustainable substrate alternatives were some of the topics covered.

Keywords: *Fragaria × ananassa,* cultivation system, field, permanent, soilless, tunnel

INTRODUCTION

Due to limited availability of disease free soils for strawberry production, adequate water and necessary infrastructure, strawberry growers are forced to use the same soil year after year. Replanting in the same soil encourages the nematode build-up as well as soil borne diseases; Production subsequently decreases over time as does size grading and fruit quality. Soil fumigation can alleviate soil health problems, but besides being expensive, it is environmentally harmful. In any case the future of most chemical soil disinfectants is uncertain in Europe (Clemens and Meesters, 2009; Lieten, 2009).

One way to avoid soil health problems is to change to a substrate based system. This system offers the possibility of permanent protection and facilitates multiple in-situ crops in a season. Any soil, close to the farm can be used and the problem of declining soil health and reduced availability is subsequently resolved. Permanent protection offers also improved labour comfort, harvest reliability, better fruit quality and a reduction in fruit rot pathogens such as

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botrytis (Xiao et al., 2001). Protected strawberry cultivation helps to meet higher market demand for fruit quality and is accepted as a typical future production system.

Belgian and Dutch strawberry growers have experimented with substrate systems since the early 80's. Eventually a standard growing method using peat-filled containers and pots on horizontal frames, the table-top system, was developed (Lieten and Baets, 1991; Lieten, 1993 and 1998). A successful soilless strawberry culture requires a grower to become a technical expert to overcome physiological and nutritional difficulties (Lieten, 2013). Table-top production also requires high investment and is very labour intensive.

In 2006 the department of field research - berryfruits at pcfruit in Belgium began looking for alternatives to soil cultivation in an attempt to avoid soil borne diseases, guarantee fruit quality and reduce the annual costs associated with constructing tunnels or table-top structures. As a result, 'the raised substrate bed' was born. Over time, several Belgian and Dutch growers began working with 'the raised substrate bed' and customized it to their own farm. The raised substrate bed system is also a growing cultivation system in Germany (Urbanietz, 2011).

The raised substrate bed cultivation system is attractive because successive strawberry crops can be cultivated in the same tunnel year after year, reducing the annual costs associated with constructing tunnels for typical tunnelled production in soil. It is cheap and relatively quick for growers to convert existing large surfaces to soilless culture (Lieten, 2009). As well as being simple, the system also enables poorer soils to be used that normally for soil cultivation would be unsuitable.

After ten years of research at pcfruit the 'raised substrate bed' system has demonstrated sound potential. Several cropping techniques for both short-day and day neutral varieties have been extensively tested. Issues such as mulch type, multi-cropping, soil heating and sustainable substrate alternatives have been extensively researched (data not shown). Recent research has focussed on substrate heating and early forcing with particular attention to day neutral varieties.

MATERIALS AND METHODS

Construction of raised substrate beds

To construct raised substrate beds (Figure 1), the soil is mechanically worked to create high (40 cm) and wide (35 cm at the top, 60 cm at the bottom) beds (Figure 2). A V-shaped trough (18 cm wide at the top and 15 cm deep) is formed in the middle of the bed. The side wall of the raised bed is convexly shaped to support flower and fruit trusses. The raised bed is covered with permeable black weed mat and the trough is filled with peat or coir substrate (20 l per running meter). A drainage system (PE-foil and a drainage tile) is added in case of a loamy soil and non-covered beds. This is not necessary for tunnelled crops or raised beds in a sandy soil.

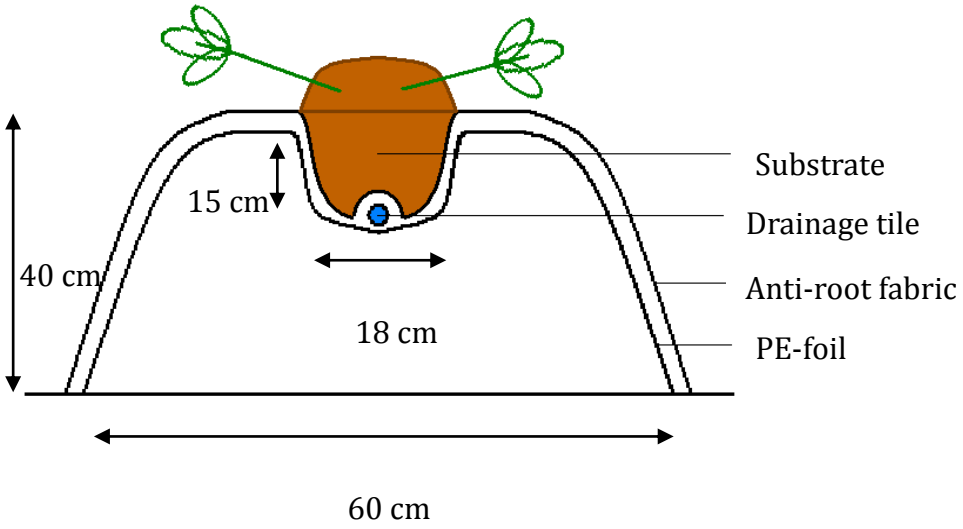

Figure 1: Schematic overview of a raised substrate bed

Figure 2: Mechanical preparation of raised substrate beds

Early forcing of a short day crop on raised substrate beds

Three different short day varieties were planted on February 29th 2016 in a tunnelled raised substrate bed system. Two heating techniques were used to warm up the substrate bed with the intention to induce an early production (Table 1). A plastic mini-tunnel was constructed around the raised bed (Figure 3a) to warm up the raised bed. In another treatment, a plant heating cable (Figure 3b) was installed in the substrate next to the roots of the strawberry plants together with the plastic mini-tunnel strategy. 250 Watt electrical plant heating cables were used with no thermostat. The cables were placed on the innerside of the substrate bed. Cables were positioned five cm from the crown of each plant. Heating of the beds commenced after planting on 29th February and continued until ambient temperatures reached 16°C and heating was deemed not necessary. The temperature (°C) near the roots of the strawberry plants in

every treatment was monitored using a PlantCare mini logger (soil temperature and soil moisture).

Table 1: Different treatments planted in a tunnelled raised substrate bed to force an early production

Variety	Planting density (plants/running meter)	Treatment
Flair	12	Control Mini-tunnel Mini-tunnel + plant heating cable
Opera	10	Control Mini-tunnel Mini-tunnel + plant heating cable
Malling Centenary	10	Control Mini-tunnel Mini-tunnel + plant heating cable

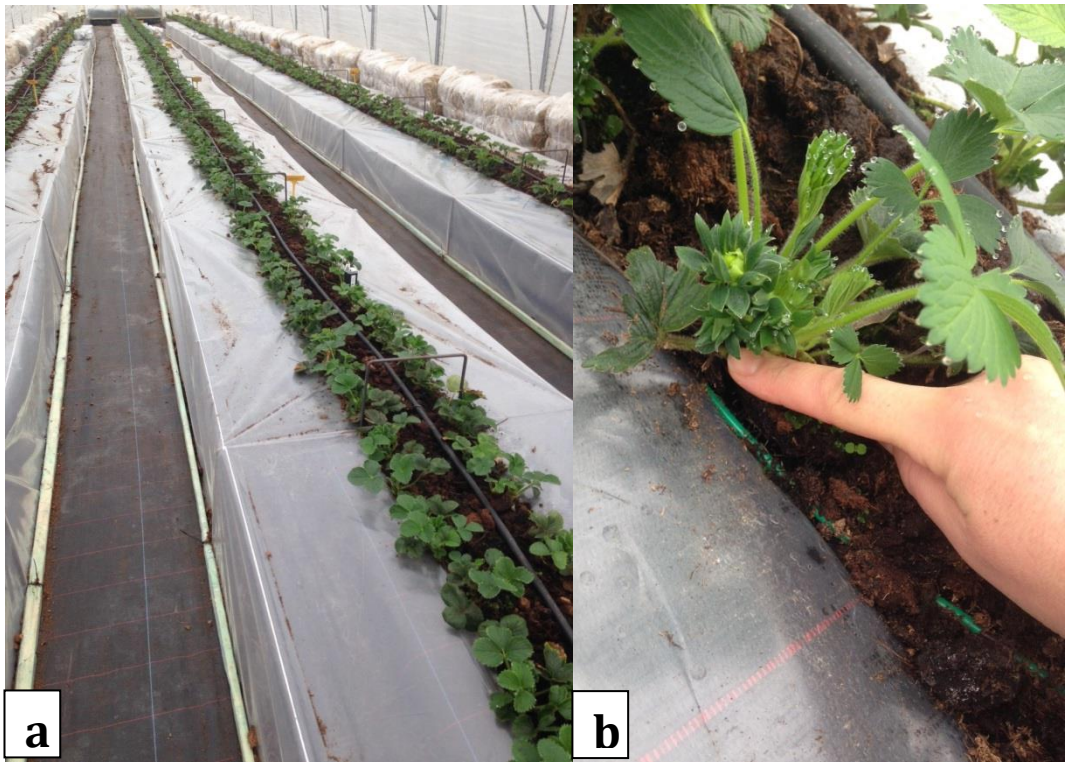

Figure 3a: Picture of a plastic mini-tunnel constructed around a raised substrate bed.
Figure 3b: Picture of a plant heating cable in the substrate near the crown of the plants.

RESULTS AND DISCUSSION

Cost effectiveness of the raised substrate bed system

Table 2 compares the cost (investment, labour and consumables) of different cropping systems. Both the investment cost (up to 2.5 times) and the yearly returning costs (up to 6€/m^2) for a table-top are higher than for a raised substrate bed system.

Table 2: Comparison of the costs of different strawberry cropping systems

Cropping system	Investment cost		Consumables	Labour cost	Total cost
	€/ha	€/m²	€/m²	€/m²	€/m²
Tunneled production in fumigated soil					
2 x short day crop	48 501	1.08	3.26	2.11	6.45
Raised substrate beds with tunnel					
2 x short day crop	84 330	1.83	4.60	3.08	9.50
Day neutral crop	84 330	1.83	2.16	2.24	6.24
Table-top production (rain cover)					
2 x short day crop	207 604	2.06	8.51	4.98	15.55
Day neutral crop	207 604	2.06	3.72	3.18	8.97

Early forcing of a short day crop on raised substrate beds

A look at the technical feasibility shows good potential for production and fruit quality on the raised substrate bed for a short day crop, a programmed short day crop and for day neutrals. In practise it is difficult to realize two programmed short day crops (60 day crops) in one season. Besides a day neutral crop, an early short day crop followed by a programmed short day crop seems the best option, although it would be interesting to get the yield as early as possible.

In the period from March 25th 2016 until April 5th 2016, an average substrate temperature of 14°C was reached in the control treatments. The treatment with the mini-tunnel reached an average substrate temperature of 16°C in the same period and for the treatment mini-tunnel combined with plant heating cables an average substrate temperature of 21°C was reached.

There were no big differences in production results between the different treatments per variety. For the cultivar 'Flair' (the earliest of the three tested varieties) the production started at the same moment for the three objects. For 'Opera' and 'Malling Centenary' a positive effect from the combination of the plastic mini-tunnel and the plant heating cables was observed, the production started respectively 7 and 4 days earlier. For 'Malling Centenary' the same effect could be noticed when only the plastic mini-tunnels was used, but for 'Opera' the early forcing reduced to 3 days instead of 7 days. Switching on the plant heating cables earlier in the season will probably increase the early forcing, possibly also for early blooming varieties ('Flair').

CONCLUSION

The raised substrate bed is a strawberry cropping system that makes it possible to cultivate strawberries continuously on the same soil. A tunneled version has the advantage of delivering higher quality fruit and eliminate the annual costs of constructing tunnels. The raised substrate bed system is much cheaper compared to a table-top system and offers a range of different cropping possibilities including heating.

Early forcing of short day varieties on a raised substrate bed system is possible. The necessary treatment is variety dependent. Later varieties ('Opera') are more responsive to early forcing compared with early varieties ('Flair').

In the end total production, fruit quality and product price determines end returns and all parameters are subject to seasonal variation.

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