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EVALUATION OF EFFICIENCY OF A NURSERY SYSTEM FOR PRODUCTION OF STRAWBERRY POTTED PLANTS IN PROTECTED CONDITIONS

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Summary

In many strawberry production areas, traditional bare-root transplants are being replaced by plug plants produced from runners. Tips (unrooted runners) are rooted into trays filled with various substrates. The success of rooting depends on various factors such as cultivar, growing medium, air humidity. The objective of this study was to evaluate the efficiency of soilless nursery to produce strawberry potted planting material. 'Elsanta', 'Grandarosa' and 'Pink Rosa' mother plants were planted in containers and set on a special rack in the greenhouse. Emerging plantlets were clipped with metal clips in micro-pots filled with peat or coconut substrate and detached from the mother plants after 14 days. Efficiency of the nursery and quality of obtained plantlets were evaluated. Efficiency of the nursery depended on the number of runners emerging from the mother plants and the number of plantlets on the runners. The highest number of plantlets was obtained from 'Grandarosa' (29.3), followed by 'Pink Rosa' (23.1), and 'Elsanta' (19.5). Rooting of plantlets before detaching them from the mother plants caused all plantlets were properly rooted. Growing media used in the experiment did not have significant influence on the plantlet rooting. The greenhouse soilless system for production of strawberry potted plantlets offers an important alternative to the conventional field grown plantlets.

Key words: growing media, plug plants, soilless nursery, cultivar, Fragaria x ananassa

INTRODUCTION

In horticultural practice strawberry is propagated vegetatively. Nowadays, traditional bare-root transplants are more and more often replaced with plug plants produced from runner tips (Lieten 2000, Durner *et al*. 2002). Due to the strong root system, which is not disturbed by digging up, plug plants establish quickly after planting and renew their growth (Pritts and Handley 1998, Hochmuth *et al*. 2006). This way of growing in substrates reduces the infection of root diseases and provides a better health status and plant productivity (Durner *et al*. 2002, Milholland and Daykin 1993). Plug plants may be available earlier than fresh-dug (bare-root) plantlets (Hennion *et al*. 1993). They can also be used for growing strawberries in organic production systems (Dolgun 2007).

Plug plant technology is fast and relatively simple. Plugs are produced in no more than 5 weeks (Pritts and Handley 1998, Treder et. al. 2007). Tips (unrooted runners) are rooted into trays filled with peat, coco peat, vermiculite, washed granite sand or mixtures of various substrates. Mother plants can be grown under protection or outdoors in horizontal or vertical systems (Durner *et al*. 2002, Treder *et al*. 2007). Rooting process is carried out in greenhouses or in plastic tunnels. The success of rooting depends on various factors such as the growing medium, temperature and air humidity (Lieten 1994). Plant size and position on the stolon also affect rooting and quality of plantlets (Takeda *et al*. 2004). During the rooting process the humidity should be high therefore plantlets should be misted intermittently (Dolgun 2007).

Treder and coauthors (2007) suggested that plantlets could be rooted before cutting them off from mother plants in order to get 100% successful establishment. In their experiment, the plantlets rooted while still being connected to mother plants had higher weight, longer roots and their crown diameter was significantly bigger in comparison with the plantlets rooted after the cutoff.

The basic characteristics used for plantlet quality evaluation are: health status, size of a root system and diameter of crown. Quick rate of establishment and optimum development after planting in the field depend mostly on the quality of the root system. The objective of this study was to evaluate the efficiency of soilless nursery to produce a strawberry potted planting material.

MATERIALS AND METHODS

The study was carried out in years 2012 – 2013 in a greenhouse located at the Research Institute of Horticulture in Skierniewice, Poland. 'Elsanta', 'Grandarosa' and 'Pink Rosa' mother plants were planted in 1.5 dm^3 containers (Table 1). The containers were filled with a 3:1 mixture of peat and coconut substrate (type ¼″) and set on a special rack in the greenhouse in the density of

20 plants/m^2. The plants were irrigated and fertigated by drip irrigation system (1 CNL dripper 2 l/h per pot; Netafim, Israel). A standard nutrient solution (N – 150 ppm, P – 45 ppm, K – 130 ppm, Mg – 20 ppm, Ca – 120 ppm) was supplied to the mother plants. The electric conductivity of 1.4 – 1.6 mS/cm was maintained. The strawberry plants were irrigated automatically based on the measurements of growing medium moisture carried out using capacitance probes (EC-5, Decagon Devices, USA). The greenhouse climatic conditions were controlled by the Priva (Holland) climate computer.

Table. 1. Time schedule of investigations.

Activity	Year	
	2012	2013
Establishment of nursery	16 Feb.	30 Jan.
Clipping plantlets	05 Jun.	02 Jun.
Cutting off plantlets after 14 days of rooting	19 Jul.	16 Jul.

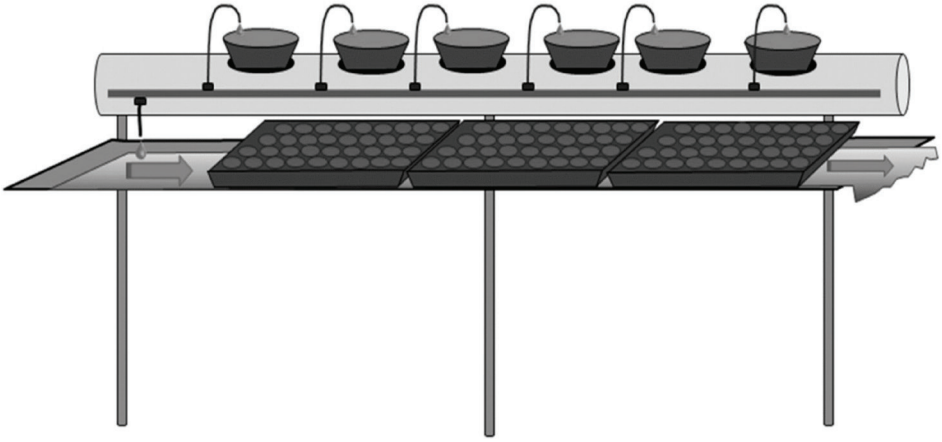
Source: own research data

Rooting of plantlets was carried out before detaching them from the mother plants (Treder et. al. 2007). For this purpose a growing rack was constructed on which the mother plants and multipots were set (Figure 1). All inflorescences emerging from the mother plants were removed to promote runnering. The multipots were placed on the capillary mat set on the platform with 0.5% decline. The mat was irrigated with a drip emitter connected to the irrigation system. The water coming out from the emitter positioned at the higher end of the platform flew down in accordance with the decline, watering the individual multipots (Figure 1). Plantlets were set (clipped with metal clips) in micro-pots of 50 cm^3 each (the density of 367 pcs/m^2) filled with two types of growing media: peat (fraction of 0 – 35 mm, pH_{H2O} = 5.5 – 5.2) or coconut substrate (type ¼″, pH_{H2O} = 6.67).

Efficiency of the nursery was evaluated by counting number of runners and number of plantlets. Plantlets were rooted for a period of 14 days (Table 1). Then, the plantlets were detached from the mother plants and their root systems were assessed. Fresh weight of roots was determined using an electronic balance. Root length measurements were carried out using root scanner and the WinRhizo software (Regent Instruments, Canada). Evaluation of the root systems was performed on 10 plantlets taken from each combination.

Experimental data were statistically analyzed using the analysis of variance, followed by means separation using Duncan's multiple-range t-test at $P \leq 0.05$. The standard error of the mean (SE) was calculated and used to indicate

error ranges on graphs. All calculations were performed using Statistica software (StatSoft Polska, Poland).



Source: own research data

Figure 1. Growing rack with platform for rooting plantlets.

RESULTS AND DISCUSSION

Efficiency of the nursery depends upon the number of runners emerging from mother plants and the number of plantlets on the runners (Treder et. al. 2007). The highest number of plantlets was obtained from cultivar 'Grandarosa'. On average, in the course of investigations each mother plant produces: 'Elsanta' – 7.3 runners which gave 19.5 plantlets per single mother plant, 'Grandarosa' – 9.6 runners which gave 29.3 plantlets per single mother plant, and 'Pink Rosa' – 7.6 runners which gave 23.1 plantlets per single mother plant (Table 2). In similar investigation carried out in Poland by Lisiecka *et al*. (2002), one 'Elsanta' mother plant gave 7-12 runners and 11-16 plantlets. Takeda *et al*. (2004) reported that each 'Chandler' mother developed about 30 daughter plants on 12 runners. Differences among the efficiency of the various strawberry cultivars were also observed by Bish *et al*. (2001).

The nursery's efficiency may depend on various factors, one of them is the planting density of mother plants. The study performed by Treder *et al*. (2007) showed that one mother plant (grown at the density of 12 plants/m^2) produced 18.7 runners whereas the plants grown at double density produced 10.6 runners. Too high density leads to the lack of light and therefore to the blanching of runners (Hennion *et al*. 1997). The efficiency of the nursery is also affected by the

length of the growing period (Lisiecka *et al*. 2002). It is possible to increase the efficiency of the nursery through delaying the time of plantlet rooting.

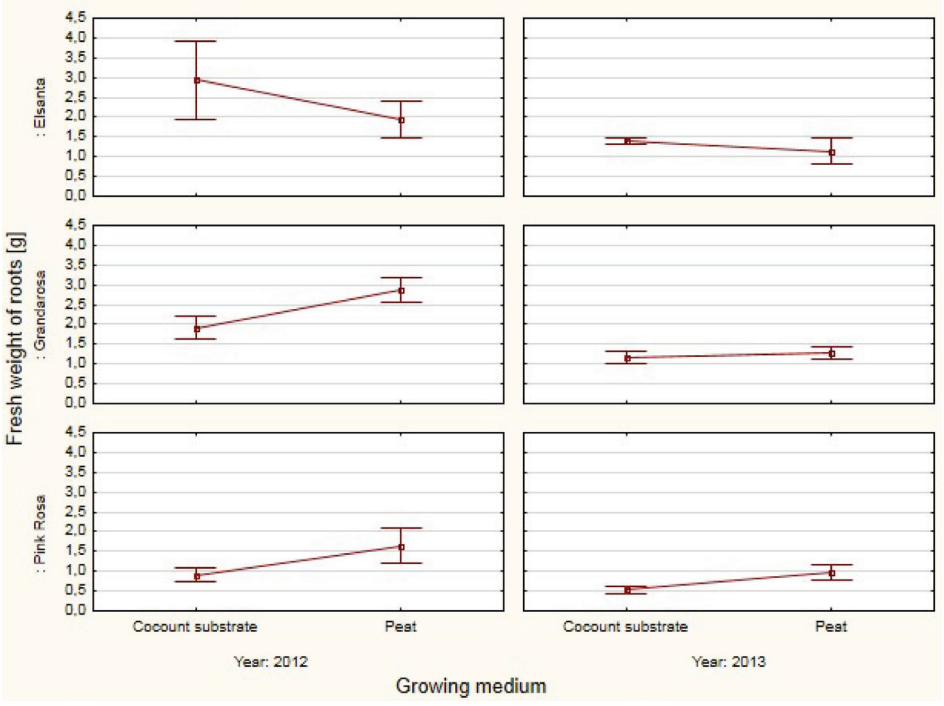
Table 2. Efficiency of mother plants.

Year	Cultivar	Parameter			
		Number of runners (pcs/plant)	Number of plantlets (pcs/plant)	Average number of plantlets (pcs/runner)	Rooting (%)
2012	Elsanta	8.22 a	18.2 a	2.41 ns	100 ns
	Grandarosa	9.56 b	23.8 b	2.28	100
	Pink Rosa	7.33 a	16.6 a	2.52	100
2013	Elsanta	6.38 a	20.8 a	3.27 a	100 ns
	Grandarosa	9.56 c	34.9 c	3.71 ab	100
	Pink Rosa	7.88 b	29.7 b	3.78 c	100
Average	Elsanta	7.3	19.5	2.84	100
	Grandarosa	9.6	29.3	2.99	100
	Pink Rosa	7.6	23.1	3.15	100

Means marked with the same letter do not differ at the significance level of $\alpha = 0.05$ according to Duncan's test, ns – not significant.
Source: own research data

During the growing season, the air humidity in the greenhouse often dropped below 40% (lack of a misting system). Lieten (2000) suggested that the relative humidity in the greenhouse be maintained at the level of 90 – 100%. For that reason misting of plantlets is recommended for a period of 10 – 12 days (Bish *et al*. 1997). As an alternative solution, plantlets can be covered with plastic for a period of 2 weeks and the temperature of the growing medium kept at 20°C. In the case of the rooting method used in the present experiment (rooting plantlets before detaching them from the mother plants), even at the relatively low humidity in the greenhouse in 2 consecutive years of investigations, the rooting efficiency of plantlets was 100% (Table 2). According to Lieten (2000), the low humidity in a greenhouse causes the runner tips to bear fewer root nodules. These often become to corky, which makes rooting less successful. According to the same author, very poor rooting was observed on too small plantlets. Such opinions were not confirmed in our study, in the case of the plantlets which were not cut off from the mother plants. Earlier investigations of Treder *et al*. (2007) showed that rooting the plantlets before their cutting off from mother plants significantly influenced the quality of the obtained planting material. The plantlets rooted while still being connected to the mother plants had bigger weight, longer roots and their crown diameter was significantly bigger in comparison with the plantlets rooted after being cut off. Using this method, 100% plantlets is properly

rooted and the greenhouse does not have to be equipped with a misting system. In the case of traditional method of rooting the result are not always 100% effective. In the experiment carried out by Takeda and Newell (2006), only 74 – 83% of plantlets formed normal root system. Higher rooting efficiency (up to 100%) was obtained by Dolgun (2007) by misting plants during rooting period.



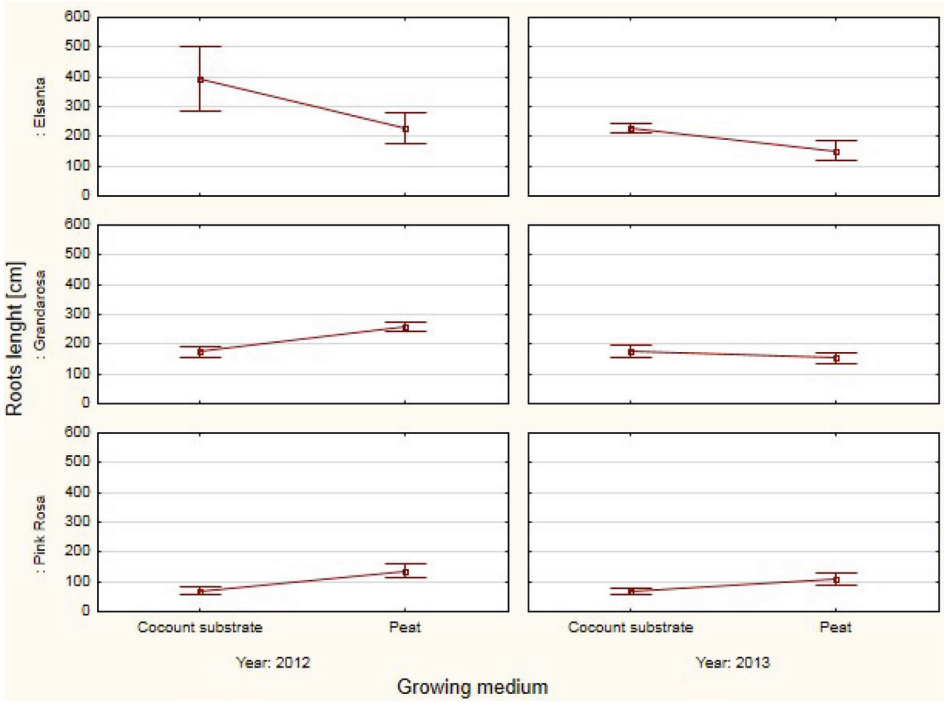
Source: own research data

Figure 2. Fresh weight of roots of strawberry plantlets depending on cultivar and growing medium used. Vertical bars represent the standard error of the mean.

Growing media did not influence the quality of plantlet rooting (Figure 2, 3). Dolgun (2007) observed small differences (up to 5%) in rooting efficiency of strawberry plantlets rooted in various growing media (peat, perlite, sand). In the present study, significant differences in root weight and root length were observed between strawberry cultivars (Figure 2, 3). Root system of 'Pink Rosa' plug plants was the least developed. The strongest root system was developed by 'Elsanta' plantlets.

Although rooted plantlets had well-developed root systems, a wilting of leaves was observed after cutting the plantlets off from the mother plants. It in-

dicates that, despite the good rooting, a large part of the water which is essential to a plantlet's existence is not taken up through its own root system but it is provided through the stolon from the mother plant. In the case, when plantlet rooting is carried out in the low air humidity conditions, the cut-off deprives plantlets of their basic source of water causing leaf wilting. However, within 24 h since detaching the plantlets, their leaves recovered turgor what indicates that the roots of plantlets quickly took over the function of water uptake. For that reason, it is recommended to cover the plantlets with foil after cutting them off for a period of 24 hours.



Source: own research data

Figure 3. Root length of strawberry plantlets depending on cultivar and growing medium used. Vertical bars represent the standard error of the mean.

CONCLUSIONS

The greenhouse soilless system for production of strawberry potted plantlets offers an important alternative to the conventional field grown strawberry plantlets. The highest efficiency of the nursery was recorded for cultivar

'Grandarosa'. Using the method presented in this study (rooting plantlets before they get cut off from mother plants), 100% plantlets was properly rooted. Both peat and coconut substrate can be recommended for rooting the strawberry plantlets.

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