Possible Improvement in Production Process of *Hedera* Potted Plants Using a Grooved Production Stake©

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INTRODUCTION

For facade greening self-clinging and twining climbers are widely used (Dunnet and Kingsbury, 2008). These climbers, such as ivy (*Hedera* sp.), are propagated mainly by cuttings.

During the growing production process in the nursery some of the elongating shoots touch each other or bend down and touch the container medium surface of neighboring pots because the pots of rooted cuttings are closely placed in a tray. Then the shoots will twine around each other or the aerial roots will grow into the container medium. The resulting plants will be difficult to lift from the tray in perfect condition for shipping if not tied up (Fig. 1). In this study, we investigated the possibility of avoiding the problems mentioned above by using a ground stake (prop) in *Hedera* pot-plant production.

MATERIALS AND METHODS

Plant Materials. *Hedera helix* 'Pittsburgh' plants (80) with eight leaves (shoot length, 11.26±0.89 cm) grown in 9-cm pots were used.

Production Stakes. Small rectangular stakes (width: 20 mm, depth: 5 mm, length: 250 mm) of Japanese cypress (*Chamaecyparis obtusa*) were used as stakes.

Experimental Design. Eighty plants were used in four experimental plots. The control plot consisted of plants with no stake supports. Stakes with three different treatments were used for the other three experimental plots and consisted of the following:

1) Coconut-fiber mat (CFM) consisting of a sheet of coconut-fiber mat (width: 20 mm, depth: 5 mm, length: 190 mm) attached to the surface of a stake [see Production Stakes above]
2) A stake [same size as (1) above] with a groove on one of the surfaces and the groove polished with a coarse sand paper (RFG)
3) A grooved stake [same size as (1) above] with the surfaces of the groove polished with a fine sand paper FFG

Stakes were inserted 5 cm into the production medium. The apical part of a shoot about 3 cm long was bound to each stake at the height of about 8 cm with a floral wire (Fig. 1).

For each experimental plot, 15 CFM stakes, 20 RFG stakes, 20 FFG stakes, and 25 control *Hedera* plants were used. In each treatment, five plants were replicated 3, 4, or 5 times, respectively. Ten plants (2×5 similarly treated plants) were closely placed in a row, and all plants were placed in eight rows on the growing bench in the greenhouse keeping the adaxial surface of a plant toward the north. The distance between each row was 20 cm. Experiment period was from 12 Sept. to 29 Nov. 2005.

Figure 1. *Hedera* shoots tied to the stakes with floral wires.

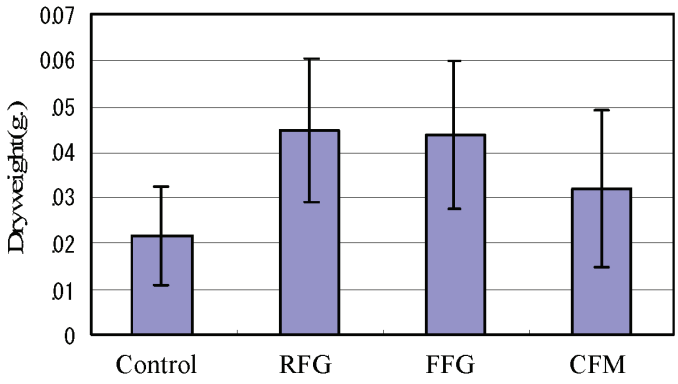

Figure 2. Dry weights of aerial roots at the termination of the experiment. Abbreviations: RFG = stake with grove polished with coarse sand paper, FFG = stake with grove polished with fine sand paper, CFM = coconut-fiber mat attached to stake.

Figure 3. Comparative morphology of clusters of adhered roots. CMF: right; RFG: left. Abbreviations: RFG = stake with grove polished with coarse sand paper, CFM = coconut-fiber mat attached to stake.

Figure 4. Aerial roots adhered to the bottom surface of the groove (left) and shoot apart from the stake (right).

Analysis of Plant Growth. The number of leaves, number of nodes where aerial roots emerged, and number of aerial roots adhering to a stake were recorded once a week. Clusters of aerial roots adhering to stakes were observed macroscopically and photographed for comparison among the three experimental plots using stakes. At the end of the experiment, fresh and dry weights of leaves, shoots, and aerial roots were determined. In addition, the number of shoots which grew parallel to a stake adhering with aerial roots (Succeed), number of shoots which grew apart from a stake and touched another plant (Touch-S), the surface of medium of neighboring pots (Touch-M), or numbers of shoots whose aerial roots grew into the medium (Rooted) were recorded.

RESULTS

Number of Leaves and Nodes with Aerial Roots. Differences in the number of leaves observed at the end of the experiment were not significantly different among the four treatments, although the control was largest (18.0) and the CFM plot (17.1) smallest. The number of nodes with aerial roots emerged was larger for the three plots using stakes than the control and the number for the RFG (11.7) was significantly larger than the control (9.6) ($p<0.05$).

Dry Weight. Dry weight (DWT) of total plant, aerial parts, and underground parts, was not significantly different among treatments (Fig. 2). Within the aerial part, DWT of the shoot without leaves and aerial roots for the control was significantly larger than other three treatments. On the other hand, DWT of the aerial roots for the RFG (0.045 g) and FFG (0.044 g) were significantly larger than the control (0.021 g) ($p<0.05$) (Fig. 2). Dry weight for the CMF (0.032 g) was also larger than the control, but the difference was not significant.

The ratio of the DWT of aerial roots within the aerial part was significantly larger for the RFG (2.82%) and FFG (2.93%) than control (1.25%) ($p<0.01$, Scheff's multiple range test).

Structure of the Adhesive Aerial Roots. There are macroscopic differences between the shape of aerial root-clusters when they attach to stakes of CMF or RFG and FFG treatments. In the case of CMF, aerial roots penetrated into the coconut-fiber; for both RFG and FFG the roots radiated outward on the surface of the groove's bottom (Fig. 3).

The Ratio of Shoots Which Grow Parallel to a Stake Adhering With Aerial Roots (SPGA). The SGPA was 65% and 70% for FFG and RFG, respectively, at the end of the experiment. For the CMF the ratio was only 33% (Fig. 4).

The Ratio of Shoots Which Grow Apart from a Stake and Touched Other Shoots (SGAT). The ratio of SGAT was smallest with the control (8.0%), and 30.0%–46.7% for the other treatments, but the rest of plants like the control had another problem such as shoots that touched the surface of the medium of neighboring pots (SGAM).

The Ratio of Shoots Which Touch the Surface of Medium of Neighboring Pots (SGAM). At the end of the experiment, all shoots of the control plants were inclined downward with 92% of shoots touching the medium surface of neighbor pots. Additionally, for 72% of them, aerial roots grew into the medium at the points where internodes touched the medium surface (Table 1).

Table 1. Details of shoots failing to grow parallel to stakes.

	SGAM*			
Treatment	Roots grew into medium	Roots did not grow	SGAT** (%±S.D.)	Total (%)
Control (n = 5)	72.0±4.89	20.0±6.32	8.0±4.90	100.0
CSM (n = 3)	20.0±11.54	0.0	46.7±16.33	66.7
RFG (n = 4)	5.0±5.00	0.0	30.0±5.77	35.0
FFG (n = 4)	0.0	0.0	35.5±5.00	35.5

*Shoot which touch the surface of medium of neighbor pot.

**Shoot which grow apart from a stake and touched a neighboring shoot.

DISCUSSION

As previously noted, pots of *Hedera* rooted cuttings are usually placed close to each other until shipping at Japanese nurseries. These *Hedera* plants are usually grown until their shoots are 30 cm long which is the shipping size. During this process, *Hedera* pot plants often have problems such as rooting into the growing medium of neighboring pots.

Present study shows that a stake is effective in avoiding some of the difficulties encountered in raising rooted cuttings of self-clinging climbers such as *Hedera helix* 'Pittsburgh'. *Hedera* cuttings can be grown upwards parallel to a stake and adhering to it. However, if a stake was not used shoots derived from the cuttings grow downward, with 92% of them touching the surface of the medium of neighbor pots and 72% were rooted into their neighbor pots.

The effect was different between the textured stake-surfaces. The grooved stake was more effective than that with coconut-fiber mat added. In the grooved stake a shoot may be assisted to grow upward by a 9-mm-wide groove. So, if a coconut-fiber mat was put on the bottom of the groove, it might also be another possibility to enhance the effect of a stake in ivy rooted-cutting production.

For the case where climbers such as *Hedera* are planted close to a wall or building for facade greening, shoots will be trained so that the shoot tips touch the surface of the wall. But, these shoots do not always grow parallel to the wall, and some of them usually grow freely without adhering to the surface of the wall. It can be considered that *Hedera* plants grown parallel to the stake may more easily adhere to the wall when planted so that the shoot tip will be close to the wall surface. In this consideration we suggest that the shoots are keeping their natural manner to grow upward adhering with aerial roots.

LITERATURE CITED

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