Productivity of Micropropagated Plants and Rooted Cutting Grafts of Rose cv. Madame Violet in Rockwool Culture

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Rose cv. Madame Violet was propagated by shoot tip culture, cutting graft, cutting, and softwood grafting, and was cultured on rockwool for 2 years. The productivity of micropropagated plants, rooted cutting-grafts, rooted cuttings, and softwood-grafted nursery plants was 9.7, 7.2, 7.6, and 4.9 flowers/plant-year, respectively, in the first year, and was 12.0, 11.1, 11.6, and 7.9 flowers/plant-year in the second year. The flowers were harvested from rooted cutting grafts and softwood grafted nursery plants every 50 to 60 days. Micropropagated plants and rooted cuttings had harvestable flowers continually. The formation of many leader shoots by rejuvenation produced the high rate and continual productivity of micropropagated plants. The length of stems, 75 to 80 cm, was the same in micropropagated plants, rooted cutting grafts, and rooted cuttings. The flowers cut from softwood grafted nursery plants were significantly shorter than those of the other plants and were below 70 cm. Of the softwood grafted nursery plants 31% were infected with crown gall.

INTRODUCTION

In Japan, there are many growers of roses for cut flowers and also the use of rockwool culture has increased. Rockwool culture has been used to root cuttings for nursery plants, and there has recently been a marked increase in the use of cutting grafts. In Holland, micropropagated plants are also used, and large-scale propagation in vitro has been done by rose nurseries.

Several researchers (Curir et al., 1986; Davies, 1980; Valles, 1987) have studied the micropropagation of roses, however, almost all of these reports are of in vitro studies. In this paper, the productivity of micropropagated plants was tested for 2 years in rockwool culture, and the productivity of rooted cutting grafts, rooted cuttings, and softwood-grafted nursery plants was also compared.

MATERIALS AND METHODS

'Madame Violet' was propagated by four methods; micropropagation, cutting graft, cutting, and softwood grafting. Micropropagated plants were initiated from shoot tips and were proliferated by subculture for 1 year on Murashige and Skoog (MS) medium plus 10^{-5} M BAP, 10^{-7} M GA_3, 3% sucrose, and 0.2% Gelrite (Fig. 1).

After root induction treatment for 6 weeks, the plants were potted in rockwool cubes (5 cm) by granular rockwool on 2 July 1991. Planting of cutting grafts, cuttings, and grafts took place on the same day. Rooted micropropagated plants, cutting grafts, and softwood grafts were kept under high humidity by mist spraying for 1 month and were then placed in a glasshouse. Micropropagated plants [(MP) 16 plants], rooted cutting-grafts [(CG) 18 plants], rooted cuttings [(RC) 17 plants],

and softwood-grafted nursery plants [(SG) 22 plants] were set on a rockwool bed on 2 September and these plants were checked every day.

After setting on the rockwool bed, the sprouted shoots under 8 mm diameter at the shoot base were turned down at the base, and the other shoots were cut back to a length of 25 cm. Flower shoots were cut off leaving two leaves with five leaflets. In July 1992, all shoots were bent at the base of the plants, and during August and September sprouting shoots were also turned down at the base.

Figure 1. Micropropagating plants on MS medium plus 10^{-5} BAP 10^{-7} GA_3, 3% sucrose, and 0.2% Gelrite

RESULTS AND DISCUSSION

The timing of cut flower production for 2 years is shown in Fig. 2. All nursery plants MP, CG, RC, and SC had four peaks of flower production in 1992 and five peaks in 1992-93. The first peak in 1992 was in early January about 120 days after setting on the rockwool bed. The period between peaks was about 60 days from November to March and about 50 days from April to June. Many leader shoots formed in MP, and RC also had leader shoots (Fig. 3). These shoots flowered between peak flowering times, therefore MP and RC had no clear break in harvesting. The productivity of MP, CG, RC, and SG was 9.7, 7.2, 7.6, and 4.9 flowers per plant-year, respectively, in 1992 and was 12.0, 11.1, 11.6, and 7.9 flowers per plant-year, respectively, in 1992-93.

The high productivity of MP seems to be related to rejuvenation because adventitious shoot initiation and much branching are one of the juvenile characteristics. Franclet et al. (1987) suggested that repetitive subculturing improved rejuvenation and the principal rejuvenation factor was the exposure of the explant

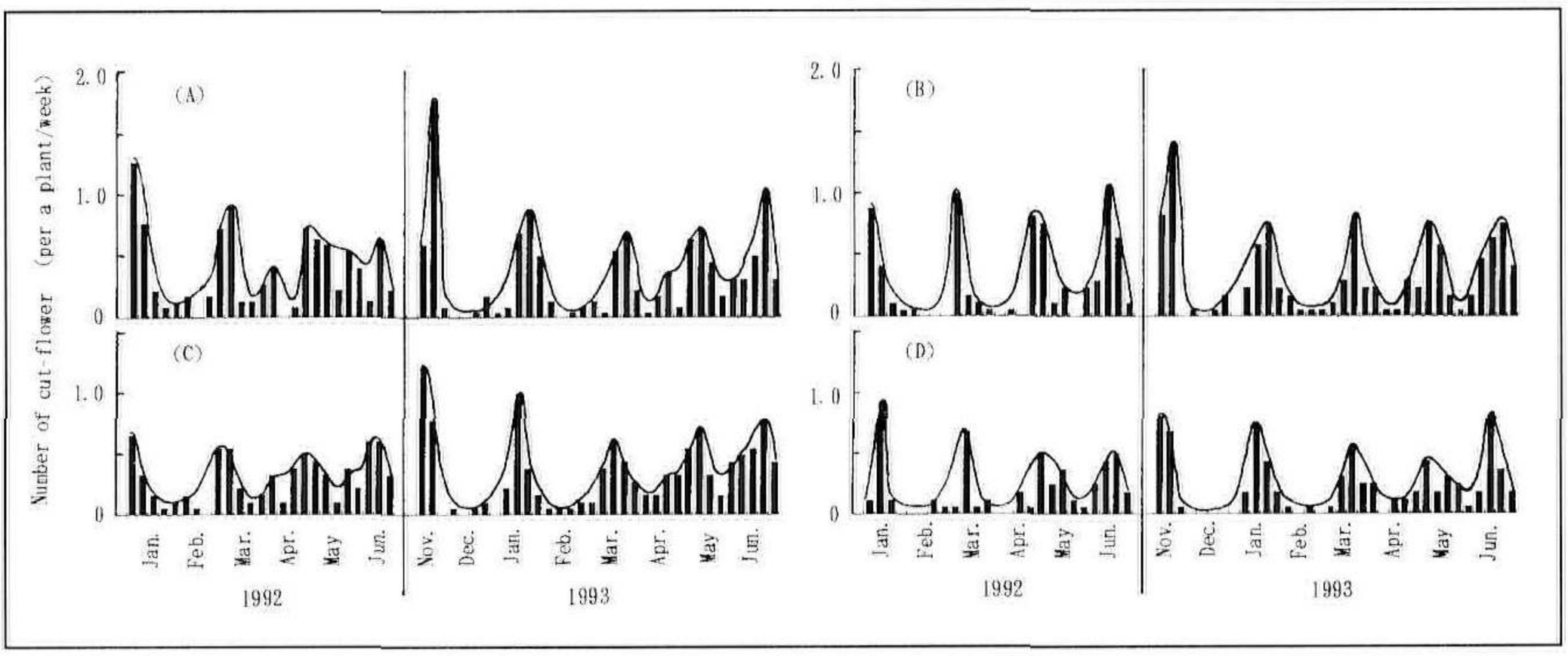

Figure 2. The periodicity of cut flower production in 1992 to 1993. A: MP (micropropagate plants), B: CG (rooted cutting grafts), C: RC (rooted cuttings), D: SG (softwood-grafted nursery plants).

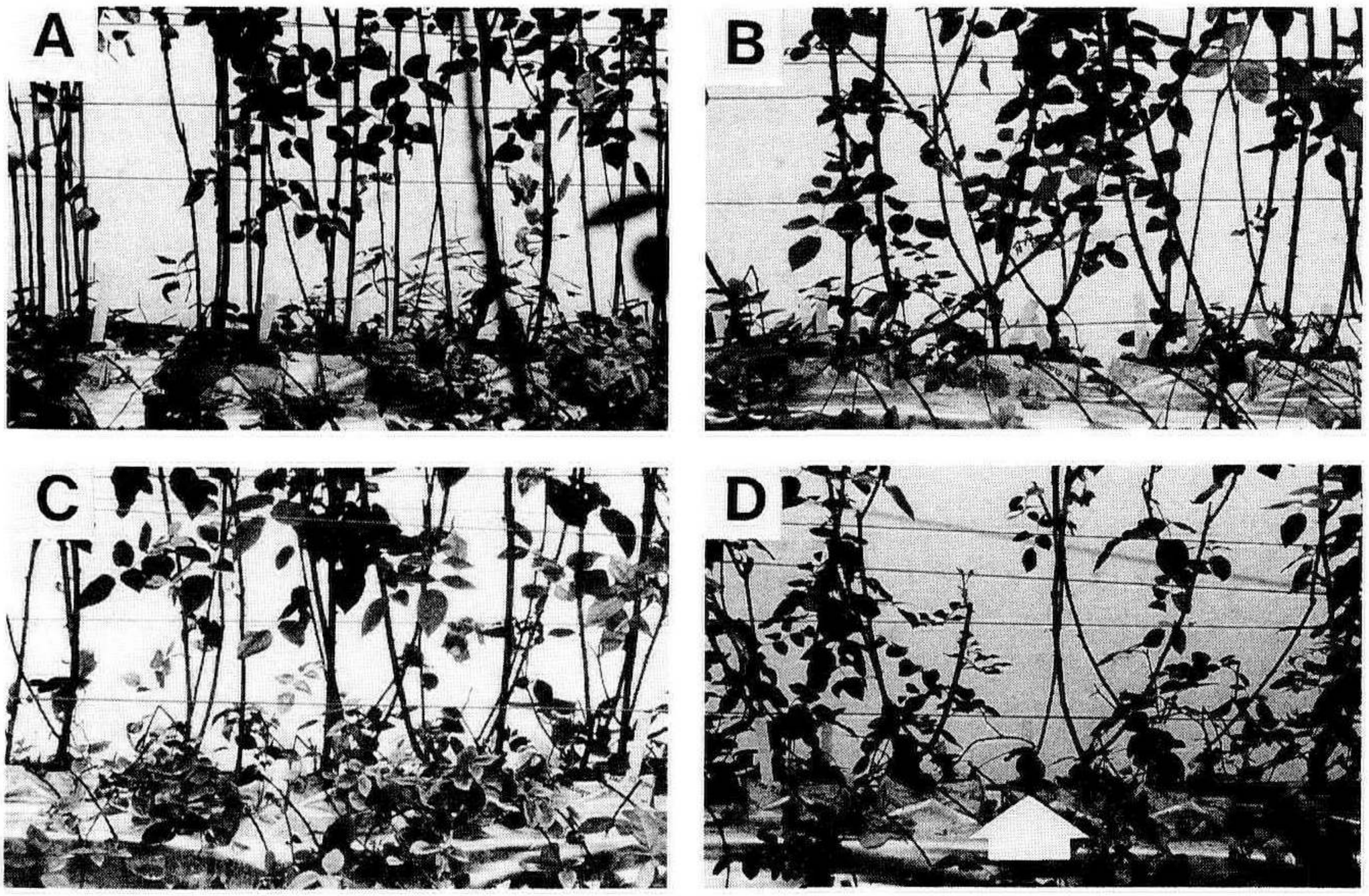

Figure 3. Sprouting shoots from A: MP (micropropagate plants), B: CG (rooted cutting grafts), C: RC (rooted cuttings), D: SG (softwood-grafted nursery plants) in July 1992. The arrow indicates crown gall.

to BAP in the medium. Jones (1994) and Dubois and Vries (1992) also reported that propagation in vitro encouraged rejuvenation of roots.

Many rose plants are infected with *Prunus* necrotic ringspot virus (Bjarnason et al., 1985) or *Prunus* virus S. These viruses reduce flower number and size, although these are often latent. The high productivity of MP may be due to its effectiveness in producing virus-free plants.

The productivity of SG was significantly lower than those of the other plants because 31% of these plants were infected with crown gall (Fig. 3).

The average length of cut flowers in 1992 showed no difference between MP, CG, and RC (Table 1), and about 50% of these cut flowers were over 80 cm. The flowers cut from SG were significantly shorter than those of other types, and most were between 60 to 70 cm in length.

In 1992-93, there was no significant difference among the nursery plants in the average length of flower stem, but the percentages over 80 cm were MP (38.9%), CG (33.5%), RC (29.8%) and SG (16.9%) (Table 1). The highest frequency of stems over 80 cm was from MP and CG, over 70 to 80 cm from RC and over 60 to 70 cm from SG. When flowers cut in 1992 are compared with those cut in 1992-93 the 1992-93 figures show more flower production but shorter stems were produced.

The flowers cut from SG were shorter than those of the other nursery plants, the most likely cause of this was the crown gall infection.

Kitamura et al. (1992) compared the field performance of micropropagated plants with that of softwood-grafted nursery plants in rose cv. Carl Red. The cut flower stem length of micropropagated plants was shorter than that of softwood-grafted nursery plants, although the micropropagated plants produced many leader shoots and much branching and therefore many flower shoots. In 'Carl Red',

Table 1. Distribution of flowers cut from MP (micropropagated plants), CG (rooted cutting grafts), RC (rooted cuttings) and SG (softwood-grafted nursery plants) for two years.

	1992						
	Stem length (cm)						
	Under 40	40-50	50-60	60-70	70-80	over 80	Average
MP	0.0[x]	0.9	4.2	20.1	25.2	49.5	77.9±11.7
CG	0.0	0.8	5.7	11.4	33.3	48.8	78.2±11.1
RC	0.0	0.7	3.0	15.6	30.4	50.4	80.4±12.8
SG	0.0	4.8	20.2	32.1	21.4	21.4	69.1±13.0

	1992 - 1993						
	Stem length (cm)						
	Under 40	40-50	50-60	60-70	70-80	over 80	Average
MP	0.0	1.9	13.7	22.5	22.9	38.9	75.6±16.0
CG	0.0	1.6	13.1	28.3	23.6	33.5	72.7±12.8
RC	0.0	3.4	12.5	23.6	30.8	29.8	74.1±15.2
SG	0.8	4.6	20.0	29.2	28.5	16.9	68.7±13.1

[x] Numbers expressed as percent.

the excess sprouting of shoots by rejuvenation, therefore, brought about a reduction in cut flower quality. The micropropagated Madam Violet used for this study sprouted many leader shoots without the excess sprouting, a known characteristic of this cultivar. The cut flower production of 'Madame Violet' was of a higher and better quality when compared with that of 'Carl Red'.

We expect to investigate cultivar differences in relation to the productivity of micropropagated plants and their sprouting ability.

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Photoautotrophic micropropagation of *Cymbidium:* Effects of CO_2 Concentration, Photosynthetic Photon Flux Density and Sucrose Concentration on Plantlet Growth

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Cymbidium plantlets are produced in vitro normally under heterotrophic or mixotrophic conditions in the presence of sucrose. Leafy nodes of other species have been grown successfully to plantlets through photoautotrophic culture (i.e. without sucrose) under CO_2 enrichment. Therefore, this study was undertaken to determine if cymbidiums in leaf can also be micropropagated without sucrose, and if so, to determine the optimum culture conditions.

Cymbidium PLBs with two or three leaves were cultured in vitro on half strength Murashige and Skoog (1962) medium under varying concentrations of sucrose, CO_2 and photosynthetic photon flux density (PPFD) for 42 days; the treatments were