range between 400 and 700 nm. Light quality (blue: 400 to 460 nm, red: 620 to 680 nm, far-red: 700 to 800 nm) affects the morphogenesis of plugs. Plug height decreases with increasing photon ratios of red to far-red regions and of blue to red regions.

Increases in the net photosynthetic rate and thus the growth rate of plugs are expected by increasing the atmospheric CO_2 concentration. Therefore, CO_2 enrichment in glasshouses will be effective in accelerating turnover in plug production.

CONCLUSION

The growth and morphology of plugs are strongly influenced by their environment. Environmental control is becoming essential to improve the quality of plugs and to reduce the production cost of plugs through rapid turnover. The methodology and techniques for plug production should be developed by means of environmental control.

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Cultivar Differences in Shoot Proliferation and Rooting of Japanese Plum (*Prunus salicina* Lindl.)

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Cultivar differences in shoot proliferation and rooting of *Prunus salicina* were investigated. The number of shoots on woody plant medium (WP) containing 2 μM BA was greater in cultivars Ooishi-nakate and Santa Rosa. While the cultivars, Ooishi-wase, King, Cocheco, Sordum, Manchurian, and Methley showed low proliferation rates. Maximum shoot length was found in 'Cocheco'. 'Sordum' had the poorest shoot elongation.

Rooting ability was higher in cultivars Ooishi-wase, King, Cocheco, Santa Rosa, Manchurian, and Methley, but that of Ooishi-nakate and Sordum were low. In most cultivars tested, IBA was more effective for rooting than NAA.

INTRODUCTION

Japanese plum (*Prunus salicina* Lindl.) originated in China. It was brought to the United States about 100 years ago, and was hybridized with *P. cerasifera, P. simomi, P. americana*, and other species to produce important cultivars. Therefore, Japanese plum cultivars have a diverse and complex genetic background. Although micropropagation methods have been successfully applied to many fruit trees in the genus, very few studies have been reported for *P. salicina* (Rosani et al., 1980; Uematsu and Akihama, 1987).

In this study, we examined cultivar differences in shoot proliferation and rooting of *P. salicina*.

MATERIALS AND METHODS

Initiation Culture. Shoot culture was established from the axillary bud of an elongating shoot in each cultivar (Ooishi-wase, Ooishi-nakate, King, Cocheco, Manchurian, Sordum, Methley). Potted trees were moved into the glasshouse in early spring. The shoots (about 15 cm long) sprouting from the buds were used to provide material for the experiments. Each shoot after leaf removal was cut to about 2 cm long. The stems were sterilised with 70% ethyl alcohol for 1 min and then with 5% sodium hypochlorite solution (0.25% active chlorine) containing 0.05% Tween-20 for 15 to 20 min. After sterilisation, stems were rinsed with sterile water three times and trimmed to 5 mm long. These nodal explants were cultured on the culture medium. Woody Plant (WP) medium (Lloyd and McCown, 1981) supplemented with 2 μM BA, 0.8% agar, 3% sucrose, was used for the initiation culture. Shoots from axillary buds were subcultured in the same shoot proliferation medium. The pH of the medium was adjusted to 5.6-5.8 with 0.1 N NaOH before autoclaving. Medium (10 ml) was dispensed into 20 mm × 120 mm culture tubes, capped with a polypropylene closure. Culture tubes containing media were sterilised in an autoclave at 121C for 15 min. The cultures were incubated at 26 C under 16-h photoperiod (40 μmol m^{-2} s^{-1}) provided by cool white fluorescent tubes (Mitsubishi FLR40SW). The cultures were transferred onto fresh medium every 30 days.

Cultivar Difference in Shoot Proliferation. After 5 to 6 subcultures, shoots of each cultivar were cultured on WP medium supplemented with 2 μM BA, 1% agar, and 3% sucrose. Because shoot growth of 'Sordum' on the sucrose medium was very poor and the subculture of these shoots was not possible, WP medium containing 3% sorbitol was used for this cultivar. After 4 weeks, the number of shoots and shoot length were recorded.

Cultivar Difference in Root Formation. Shoots of each cultivar, about 7 mm long were cultured on WP medium supplemented with 0.1 μM IBA or NAA. The cultures were incubated at 26 C under 16-h photoperiod (40 μmol m^{-2} s^{-1}) provided by cool white fluorescent tubes (Mitsubishi FLR40SW). After 4 weeks, the number of roots per rooted shoot and the root length were recorded.

RESULTS AND DISCUSSION

Shoot Proliferation. Table 1 shows the shoot growth of each cultivar on WP medium. The number of shoots on WP medium containing BA was greater in cultivars Ooishi-nakate and Santa Rosa, while other cultivars, Ooishi-wase, King, Cocheco, Sordum, Manchurian, and Methley, showed low proliferation rates. Greatest shoot length was obtained in the cultivar Cocheco, followed by King, Ooishi-wase, Methley, Santa Rosa, Ooishi-nakate, and Manchurian. 'Sordum' had the least shoot elongation. When single shoots of plum were placed in the medium, the shoot proliferation rate was low in most cultivars. However, when a clump with 2 to 3 shoots was placed in the medium, a large number of shoots was obtained in many cultivars after 30 days of culture (data not shown).

Table 1. Cultivar difference in shoot proliferation of Japanese plum.

Cultivar	No. of shoots	Maximum shoot length (mm)
Ooishi-wase	1.5±0.2[1, 2]	9.3±0.4
Ooishi-nakate	4.1±0.6	8.6±0.4
King	1.8±0.3	9.9±0.4
Cocheco	2.1±0.3	14.2±0.7
Santa Rosa	3.8±0.6	8.9±0.6
Sordum	1.6±0.2	4.2±0.2
Manchurian	1.6±0.2	8.4±0.4
Methley	1.2±0.1	9.0±0.3

[1] mean±S.E.
[2] Each value represents the mean of 15 replicates.

Root Formation. Table 2 shows the rooting ability of each cultivar on WP basal medium (auxin-free) and on WP medium supplemented with IBA or NAA.

Cultivars Ooishi-wase, King, and Manchurian showed higher rooting percentages on the auxin-free medium. Rooting ability was higher in cultivars Ooishi-wase, King, Cocheco, Santa Rosa, Manchurian, and Methley, but that of Ooishi-nakate and Sordum was low. In most cultivars tested, IBA was more effective for rooting than NAA.

Rosati et al. (1980) reported that shoot proliferation of Japanese plum cultivar Calita was greatest on modified MS medium supplemented with 1 mg liter^{-1} BA, 0.1 mg liter^{-1} GA_3, and 0.1 mg liter^{-1} IBA. Uematsu and Akihama (1987) reported that shoot proliferation of Japanese plum cultivars Ooishi-wase and Taiyou was greatest on ½ MS medium supplemented with 4PU or BA. In our preliminary study, results indicated that the survival rates of shoots during subcultures were higher on WP medium than on MS medium, especially for cultivars King and Sordum. Therefore, we used WP medium for this study. The results in this study indicated that there are cultivar differences in shoot proliferation rates and rooting ability among Japanese plum cultivars. However, the relationship between these cultivar differences in proliferation rate and rooting, and the genetic background of each cultivar was not clear. For example, although 'Ooishi-wase' and 'Ooishi-nakate' have a similar genetic background, their rooting abilities were very different.

It has been suggested that the genotype is one of the most influential factors in determining proliferation or rooting responses. In the rooting of apples, differences among cultivars have been found in response to auxin concentration (Zimmerman et. al., 1985). In apricots, Marino et. al, (1991,1993) showed that shoot multiplication was influenced by carbon sources in the media. In our study, shoot growth of 'Sordum' on sorbitol medium was greater than that on sucrose medium, which indicates that there may be cultivar differences in sugar requirement for shoot growth and rooting. Further studies involving sugar and hormone requirements are needed to determine the cause of cultivar differences in shoot proliferation and rooting.

Table 2. Cultivar difference in rooting of Japanese plum.

Cultivar	Auxin	Rooting (%)	No. of roots	Maxmum root length (mm)
Ooishi-wase	HF[1]	15.0[2,3]	1.3±0.2	36.5±2.5
	IBA	80.0	1.5±0.2	21.4±2.3
	NAA	60.0	1.3±0.1	37.9±2.1
Ooishi-nakate	HF	0	-	-
	IBA	20.0	1.0±0.0	32.8±3.4
	NAA	10.0	2.0±0.4	37.3±3.4
King	HF	65.0	1.7±0.2	29.1±2.9
	IBA	55.0	3.3±0.3	13.3±1.5
	NAA	60.0	2.2±0.2	9.3±0.9
Cocheco	HF	21.1	1.0±0.0	30.5±4.3
	IBA	95.0	3.4±0.4	9.5±1.3
	NAA	75.0	1.7±0.2	13.0±2.2
Santa Rosa	HF	25.0	1.2±0.1	73.1±5.8
	IBA	100	2.9±0.4	32.4±2.4
	NAA	90.0	2.4±0.3	35.7±3.5
Sordum	HF	5.0	1.0±0.0	6.0±0.0
	IBA	20.0	1.5±0.2	37.0±4.3
	NAA	40.0	2.3±0.2	18.2±2.2
Manchurian	HF	90.0	2.5±0.2	38.4±1.7
	IBA	90.0	2.9±0.4	26.8±2.9
	NAA	95.0	2.7±0.4	11.4±0.9
Methley	HF	17.6	1.0±0.0	9.5±1.6
	IBA	94.7	1.8±0.4	16.1±1.9
	NAA	60.0	2.0±0.3	19.1±3.1

[1] HF: Hormone free
[2] Mean ± S.E.
[3] Each value represents the mean of 15 replicates.

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