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Seedling Propagation by Stem Cuttings in Yacon

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ABSTRACT

Four experiments were conducted to determine growth regulators, their concentrations and treatment time, rooting medium, and plant parts for optimum seedling propagation by stem cuttings in yacon (*Polymnia sonchifolia* Poepp. & Endl.). NAA was the most effective on rooting, and followed by IBA 2,4-D, and IAA. Dipping the base of cuttings in 50 or 100 ppm solutions of IBA increased rooting ratios. The 100 ppm solution of IBA was 14% higher than the 50 ppm solution for rooting ratios. Rooting medium with equal volumes of clay loam and sand was the most suitable for rooting of cuttings. Cuttings with both terminal bud and the first node or cuttings with both the first and second nodes were higher in rooting ratios than cuttings with only terminal bud or the first or second nodes. Days to rooting was not affected by plant parts.

Key words: yacon, *Polymmia somchifolia*, stem cutting, auxins, dipping period, plant part, rooting media.

Though yacon has dark yellow flowers with 2~3 cm in diameter, it hardly bears fruits. So, farmers usually multiply yacon seedlings by vegetative propagation. There are three ways for vegetative propagation in yacon; the first one is planting crown buds, the second is dividing and planting seedlings grown from crown buds after tentative plantation, and the third is cutting seedlings of the second method. The first two methods need a great amount of crown buds as compared to the third one.

To get cuttings, harvested crown buds in the preceding year need to be stored for overwintering and to be warmed in spring for sprouting. Sprouts from the crown buds can be used as cuttings. Treatment of cuttings with auxin treatments using IBA, NAA and sulfuration are effective on rooting (Chian, 1989). NAA and Rootone-F promoted rooting in *Arachis hypogaea* and *Eleutherococcus senticosus*, respectively (Park et al., 1994; Lee et al., 1983). Internal factors such as crop age, the amount of reserved nutrition, C/N ratio, and growth regulator and hormone -like- materials and external factors such as bed soil, temperature, moist, and light are related with rooting of cuttings (Reuter, 1971; Runguist & Stefansson, 1973; Shim et al., 1993). In addition, there are reports that cutting time is different depending on crop species and ages (Hitchcock & Zimmernan, 1940).

Yacon propagates by cutting and division. The former is more effective than the latter because of high propagation ratio. The rooting of cuttings can be affected by species, rooting accelerator, cutting parts, and rooting media (Kim et al., 1995; Kim et al., 1995; Park et al., 1994; Lee et al., 1983). On the other hand, some studies were conducted on the seed tuber processing of *Amorphophallus konjac* and the vegetative propagation of bulb and tuber plants (Song & Roh, 1997; Joo et al., 1987; Jo, 1982, 1983).

Seedling propagation by cuttings has not been established in Korea since yacon was imported from Japan in 1985. Therefore, the present studies were carried out to determine the optimum growth regulators and their concentrations, the best plant parts and rooting media for rooting of yacon cuttings.

MATERIALS AND METHODS

Crown buds of yacon (*Polymnia sonchifolia* Poepp. & Endl.) were obtained from the National Crop Experiment Station, Rural Development Administration in 1994, and were propagated by planting crown buds on the nursery fields at Chonbuk National University on April 20 1995. In early November, the harvested crown buds from the nursery fields were stored in the chamber at 10±1℃ and dark condition, and used on March, 1996.

Crown buds were planted to get the host plant after divided to single bud and irrigated once every three days in single-layer polyethylene-covered greenhouse (6 W×14 D×2.5 H m). Cuttings were prepared from the host plant when shoot was 20 cm long or taller. Each cutting consisted of a 2~2.5 cm hypocotyl and two primary leaves including one node.

The effects of two levels (50 or 100 ppm) of 2,4-D (2, 4-dichloro phenoxyacetic acid), IAA (Indole-3-acetic acid), IBA (3-indole butyric acid) and NAA (α -naphthaleneacetic acid) was tested on rooting. In each treatment, 36 cuttings were dipped for 2 hours and then planted 1 cm deep in plastic trays (72 unit, 27.5×54.0×4.0 cm). Plastic trays were filled up with equal volumes of compost and clay loam. To get the optimistic treatment time, the base cuttings were dipped for 1 or 2 hours in the IBA solutions with either 50 or 100 ppm, and planted as mentioned above. The effects of various rooting media of compost, clay loam, sand, mixture of compost:sand

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Table 1. Physio-chemical properties of compost.

pH	Conc. of salts (dS /m)	OM (%)	Air permeability (%)	N (mg /L)	P_2O_5 (mg /L)	K_2O (mg /L)
5.5~6.0	1,517	80	10~14	210	240	270

(1:1=v:v), mixture of compost:clay loam (1:1=v:v), mixture of snad:clay loam (1:1=v:v), and mixture of compost:sand:clay loam (1:1:1=v:v:v) were tested on rooting. Used compost was made by Bulrush Co. in England, and the physio-chemical properties are shown in Table 1. To investigate the effects of plant parts and the number of nodes on rooting, terminal bud, the first and second upper nodes, the first node including terminal bud, the first and second upper nodes, and internode without any node were tested, when terminal bud, the first and second upper nodes were 2.5 cm long, respectively. The others were 2.5 cm or longer.

Plastic trays were arranged using randomized complete block design and three replications. These experiments were began on March 24 in single-layer polyethylene-covered greenhouse (tunnel type) that was controlled at 25±4℃, blinded with 70% shading net, and irrigated every other day. Rooting ratio was the ratio of rooted cuttings to 36 cuttings, and root numbers and root length were measured after 20 days of cutting. When roots were longer than 0.1 cm, their numbers were counted. After 10 days, days to rooting were checked on rooting individually, it was the required days on rooting ratio.

RESULTS AND DISCUSSION

Planted cuttings with nodes rooted at the area of cut base after 15 days of cutting (Fig. 1). Rooting ratios, root numbers per cutting, root length, and days to rooting were measured depending on growth regulators and their concentrations as shown in Table 2. NAA was the best for rooting and followed by IBA, 2,4-D, and IAA. The rooting ratios were 25% in the control, 94.4% in 100 ppm NAA and 88.9% in 50 ppm NAA. The rooting ratios were 69.4% when treated with 50 ppm IBA and 80.6% with 100 ppm IBA. No significant differences for the rooting ratios were observed between 50 and 100 ppm for 2,4-D, IAA, and NAA treatments.

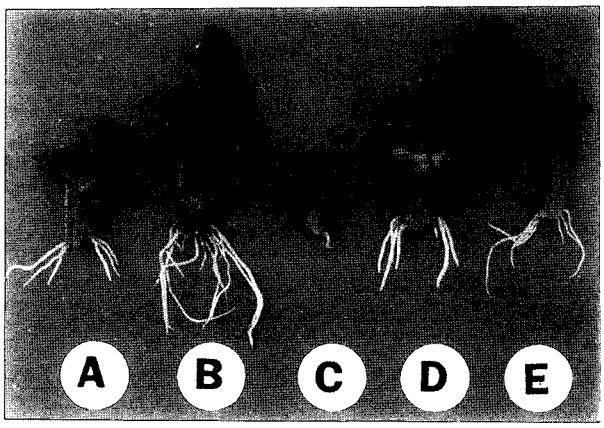

Fig. 1. Types of various rootings from cuttings after 15 days of cutting in yacon.
(A)IAA 100 ppm, (B)NAA 100 ppm, (C)control, (D)IBA 50 ppm, (E)IBA 100 ppm.

The numbers of roots per cutting in NAA and IBA solutions were 9.8 and 9.1 respectively. On the other hand, the number of roots per cutting for control was 1.2. The mean root length was 0.3 mm in the control, 5.7 mm in NAA, and 4.7 mm in IBA, indicating that the root length per cutting treated with auxins was about 15 times

Table 2. Effects of auxins on rooting in stem cuttings of yacon.

Treatments		Rooting ratio (%)	Root numbers per cutting	Root length (cm)		Days to rooting
Auxin	Conc. (ppm)			Mean	Range	
Control	0	25.0	1.2	0.3	0.1~0.5	20
2,4-D	50	36.1	4.0	0.7	0.4~1.1	20
	100	41.7	4.1	0.6	0.3~1.1	18
IAA	50	22.2	6.3	2.7	0.6~3.2	19
	100	25.0	6.5	3.1	0.6~3.5	18
IBA	50	69.4	8.7	4.5	0.5~5.3	17
	100	80.6	9.1	4.7	0.5~5.2	17
NAA	50	88.9	8.9	6.3	0.6~7.7	15
	100	94.4	9.8	5.7	0.5~7.1	16
LSD (0.05)		1.8	1.0	0.9		0.6
C.V. (%)		5.2	9.1	15.6		1.9

longer than that in the control. It took 20 days to rooting in the control while 15~16 days in NAA treatment and 17 days in IBA treatment. The number of roots per cutting treated with IAA was five more than that of the control. The mean root length of cutting treated with IAA was 9 times longer than that of the control. However, the rooting ratio for IAA treatment was lower than the control. This indicates that IAA is not suitable for rooting of yacon.

Treatments with 1% IBA or 1,000 ppm NAA were effective on rooting of *Solanum muricatum* cuttings (Morley-Bunker, 1983; Joo et al., 1987). Two ppm IBA was the most effective on rooting and root growth in *Panax ginseng* cuttings (Jo, 1983). NAA was effective on rooting in peanut (Lee et al., 1983), *Ligusticum chuanxiong* (Kim et al., 1995) and *Panax ginseng* cuttings (Jo, 1982). When peanut cuttings were treated with NAA and IAA, no significant differences were observed for their concentration levels. However, the rooting ratio of cuttings treated with 2,000 ppm was lower than that with 500 ppm (Lee et al., 1983). These previous studies showed that rooting of cuttings may be different depending on growth regulators and their concentrations as well as plant species.

When the base of cuttings was dipped in 50 and 100 ppm of IBA soultions for 1 or 2 hours, the rooting ratios in 50 ppm for 1 hour were 61.1% and 69.4% for 2 hours, whereas the ratio in 100 ppm for 1 hour was 77.8% and 80.6% for 2 hours. This indicates that there was significant differences for two dipping periods (Table 3). However, there was no significant differences in the root numbers per cutting, root length, and rooting days for two dipping periods.

Rooting of cuttings was affected by rooting media as shown in Table 4. The rooting ratio was about 30% when cuttings were planted in rooting media with either consisted of compost or sand. In clay loam, the rooting ratio of cuttings was 16.7%. The number of roots per cutting was less than 6 and the mean root length was less than 3 cm in compost, sand or clay loam media. The mean root length is only 1/10 and 1/2 of that (3.8 cm) in the mixture of compost and clay loam. When cuttings were planted in rooting media with equal volumes of compost, clay loam and sand, the rooting ratio (70.8%) was higher than those in rooting media with only one component, but was lower than those (81.9~88.9%) in rooting media with mixtures of any two components. The number of roots per cutting (8.2 ea) in the rooting medium with all three components was smaller than that (10 ea) in the rooting medium with compost and sand. The root length (2.9 cm) in the former was shorter than that (3.8 cm) in the latter. The number of days to rooting was shorter in the rooting medium with equal volumes of compost and sand than other media.

Our results suggest that the rooting medium with equal volumes of clay loam and sand is the most effective in

Table 3. Effects of different IBA concentrations and dipping periods on rooting in stem cuttings of yacon.

Conc. of IBA (ppm)	Dipping periods (hr)	Rooting ratio (%)	Root numbers per cutting	Root length (cm)		Days to rooting
				Mean	Range	
0	0	25.0	1.2	0.3	0.1~0.5	20
50	1	61.1	8.0	0.7	0.3~4.9	18
	2	69.4	8.7	0.6	0.5~5.3	17
100	1	77.8	8.5	2.7	0.2~4.9	17
	2	80.6	9.1	3.1	0.5~5.2	17
LSD (0.05)		1.0	1.8	0.8		1.0
C.V. (%)		2.4	13.5	11.7		3.1

Table 4. Effects of rooting media on rooting in stem cuttings of yacon.

Rooting media	Rooting ratio (%)	Root numbers per cutting	Root length (cm)		Days to rooting
			Mean	Range	
Compost (Co)	27.8	5.8	2.7	2.0~3.0	18
Clay (Cl)	16.7	2.0	0.5	0.3~0.6	19
Sand (Sa)	31.9	5.0	2.3	2.2~2.5	17
Co+Cl	52.8	11.2	3.8	3.2~4.7	18
Co+Sa	81.9	10.0	0.3	0.1~0.8	13
Cl+Sa	88.9	7.0	1.5	1.0~2.0	15
Co+Cl+Sa	70.8	8.2	2.9	0.6~4.2	16
LSD (0.05)	1.0	0.9	0.7		0.9
C.V. (%)	1.4	7.4	20.9		2.9

Table 5. Effects of plant part and the number of node on rooting in stem cuttings of yacon.

Plant parts†	Rooting ratio (%)	Root numbers per cutting	Root length (cm)		Days to rooting
			Mean	Range	
TB	52.8	5.8	3.6	0.2~4.3	18
FN	72.2	8.9	4.5	0.5~5.2	18
SN	77.8	9.2	4.7	0.6~5.1	17
TB with FN	88.9	10.4	5.0	0.6~6.9	18
FN with SN	91.7	11.3	5.2	0.9~7.4	17
Internode	0.0	0.0	0.0	0.0~0.0	-
LSD (0.05)	2.2	0.9	1.9		1.4
C.V. (%)	5.3	6.6	27.1		5.1

†TB;terminal bud, FN;the first node, SN;the second node

yacon cuttings. The optimistic rooting medium is sandy loam for cuttings in *Camellia sinensis* (Kim et al., 1995). The rooting ratio (80.5%) was higher in the rooting medium with equal volumes of peatmoss, vermiculite, and bark than that (52.5%) in the sand in *Populus davidiana* (Roh et al., 1995). The rooting ratio for clematis was higher in the rooting medium with the mixture of vermiculite and ProMix(1:2, v:v) than others (Song & Roh, 1997). When stems of ginseng were planted in the mixture of leaf mold and sand and treated with 1.0 ppm NAA, the rooting ratio and root growth after rooting were excellent (Jo, 1982). These results show that the physical properties and the moisture holding ability in bed soils need to be kept at proper levels to promote rooting.

Rooting of cuttings was affected by the plant parts as shown in Table 5. The rooting ratios (72.2% and 77.8%) of the cuttings including the first or second nodes from the top of the stem were higher than that (52.8%) of the cuttings with only terminal bud. However, the ratios were 88.9% and 91.7% for the cuttings with both terminal bud and the first node, and for the cuttings with both the first and second nodes from the top of the stem, respectively. The number of roots per cutting was 10 or more in cuttings with both terminal bud and the first node and in cuttings with both the first and second nodes from the top of the stem. On the other hand, 5.8 roots were observed per cutting with only terminal bud. The mean root length and rooting ratio showed similar tendencies to the root numbers per cutting. However, there were differences among plant parts for the days to rooting. Roots were not developed at all in cuttings with only internode, suggesting that nodes may play an important role in rooting.

The rooting ratio ranged from 94% to 100% in the first node and 56% to 64% in the second node from the bottom of the stem of *Ligusticum chuanxiong* (Kim et al., 1995). In the present study, cuttings with two nodes were more effective than that with one node for cutting in yacon. This result is similar to that of peanut (Lee et al., 1983).

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