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# Sprouting Condition of Crown Bud and Plug Seedling Production in Yacon

Hong Soo Doo*, Byung Kil Choo**, and Jeom Ho Ryu***

## ABSTRACT

**The objectives of this study were to find the sprouting condition and to establish the optimum production methods of plug seedlings in yacon (*Polymnia sonchifolia* Poepp. & Endl.). The sprouting ratio was greatest at 30±1℃ at 20 days after planting. Crowns with single buds were more effective than those with two or more buds for sprouting, which might be due to the apical dominance. Planting the shoots separated from crown after sprouting in the single- and double-layer polyethylene-covered greenhouses reduced seedling period with 25% and 50%, respectively. Planting the shoots after sprouting was more effective than planting the crown buds. Double-layer polyethylene-covered greenhouse was good for plug seedling production than open field or single-layer polyethylene-covered greenhouse. The bed soils composed of clay loam : compost or sand : compost (1:1=v:v) were more effective to produce plug seedlings than only clay loam, sand or compost. Seedlings could be produced at 30 days after planting in our studies.**

**Key words : yacon, sprouting, temperature, plug seedling proliferation.**

It has been 15 years since yacon was introduced to Korea from Japan. However, studies on cultivation, production and utilization of yacon have not been actively enough. Yacon has not been widely informed to the public, either. Cultivation of yacon is suitable in Korea in terms of climate condition. However, cultivation methods have not been established, yet. The radicle proliferation of yacon is difficult because plants themselves and crown buds cannot overwinter in natural conditions. Therefore, farmers depend on their own experiences of cultivation.

In Korea, yacon has been utilized as one of the major ingredients in various foods including iced noodles, chopped noodles, fries, pancakes and dumplings. More studies on yacon are required since the domestic demand of yacon is presumed to be increased in the near future.

According to traditional cultivation, it takes 50 to 60 days from replanting crown buds on nursery fields to planting seedlings and another 150 days after seedling planting. This means that it takes a long time (about seven months), and money to grow and cultivate yacon. Since the growth steps of individual seedlings are not the same in the traditional method, their growth stages would be different after planting on the same field which brings another difficulties for farmers for cultivation. Without these problems, farmers would get lots of yacon seedlings in easy way, grow them in the same growth stages, and eventually promote the economical production.

Bed soils for seedling growth need to have little component changes throughout the whole growing period. Quick suction force of water, excellent moisture holding ability and chemical stability should be kept in bed soils for a long time. Bed soils themselves also need to be light. So far, any studies have not been reported on sprouting and seedling proliferation of yacon. On the other hand, seed tuber processing of *Amorphophallus konjac* and vegetative propagation of bulb and tuber plant have been reported (Song & Roh, 1997; Lee, 1992b; Joo et al., 1987; Jo, 1982, 1983).

Excellent seedlings are believed to be the parameter of their successful cultivation. The present study was carried out to investigate the budding conditions from crown buds and seedling proliferation by plug seedlings.

## 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 crowns on the nursery fields at Chonbuk National University on April 20, 1995. In early November, crown buds harvested from the nursery fields, were stored in the chamber at 10±1℃, and dark condition, and used on March, 1996.

To find the effects of temperature on sprouting, 20 crowns with one bud were planted at a depth of 1 cm in a pot (34W×21D×5H cm) filled with sandy loam. Treatments consisted of 5 different temperatures ranged from 10±1℃ to 30±1℃ at 5℃ intervals in the dark condition and 80% of moisture. In particular, there were two light conditions (dark and light at 25±1℃).

To investigate the effects of crown bud numbers on

* The Institute of Life Science & Natural Resources, Wonkwang University, Iksan 570-749, Korea.
** Dept. of Agronomy, Graduate School, Chonbuk National University, Chonju 561-756, Korea.
*** Faculty of Biological Resources Science (The Institute of Agricultural Science & Technology), College of Agriculture, Chonbuk National University, Chonju 561-756, Korea.
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sprouting, 20 crowns with one, two, three, and four buds were planted at a depth of 1 cm in a pot (34W×21D×5H cm) filled with sandy loam:clay loam (1:1=v:v). The pots were placed in a single-layer polyethylene-covered greenhouse, and irrigated every three days. The pots were arranged in randomized block design with three replications.

Crowns sprouted for 30 days in a chamber at 25±2℃ in the dark condition. Shoots were grown to 2 cm or taller after sprouting. To find optimum conditions for raising plug seedlings, 50 shoots were separated from crowns, and planted on the three fields, respectively, that were located on the open, single- or double-layer polyethylene-covered greenhouses on March 24, 1996.

To select the best medium for raising plug seedlings, 72 shoots with about 2 cm long were planted in plastic trays (72 units, 27.5L×54.0W×4.0H cm) that were filled with clay loam, sand, Compost, clay loam:Compost (1:1=v:v) or sand:Compost (1:1=v:v) on March 24, 1996. Plastic trays were placed in a double-layer polyethylene-covered greenhouse, and were arranged in randomized block design with three replications. Compost made by Bulrush Co. in England, its physio-chemical properties were shown in Table 1.

Ratios of leaf unfolding, plant height, leaf number, leaf length, leaf width, root numbers, and root length were measured at 30 days after planting.

## RESULTS AND DISCUSSION

### Sprouting condition

The sprouting ratios increased and the mean sprouting dates were shortened as the air temperature increased from 5 to 30℃ (Fig. 1). At 25℃, shoots started to appear at 5 days after planting and 95% of buds sprouted up within 40 days after planting. At 30℃, however, 85% of buds sprouted up within 15 days, which was faster than at 25℃ or below. Shoots started to appear in 25 days and 60% sprouted up within 40 days after planting at 15℃. On the other hand, shoots appeared in 30 days and only 10% sprouted up within 40 days after planting at 10℃. These results are similar to that of Cho et al. (1984) who reported that optimistic temperature for sprouting of sweet potato was 30~33℃. There was no significant difference in sprouting between light and dark conditions at 25℃. In the dark condition, however, leaves were folded and the shoots showed albinos. Our results agree to that of Kang (1970) in which shoots in the field were much healthier than that in the dark and cool condition.

Sprouting ratio was significantly affected by the number of crown buds (Fig. 2). When crowns with only one bud were planted, 90% of buds sprouted at 40 days after planting. However, only 51.2% of buds sprouted at 40 days after planting when crowns with four buds were planted. It seems that the apical dominance occurs among crown buds. After the first apical bud reaches to the stable growth stage, the second apical bud starts to grow. Planting crowns with many buds seems to be inappropriate to obtain many seedlings because of the apical dominance. Therefore, we recommend that planting crowns with single buds is best to obtain a number of uniform seedlings. Also, Lee (1992) reported that the number of bulblet of *Amorphophallus konjac* was increased by two or four split method of seed tubers. This method was proven to be profitable for mass propa-

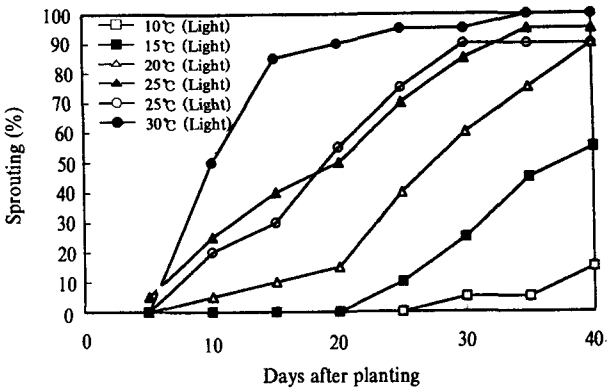


Fig. 1. Effect of air temperature on bud sprouting in yacon.

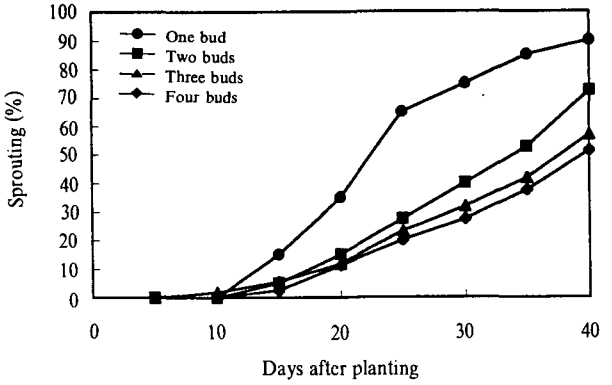


Fig. 2. Effect of the number of buds per crown on sprouting in yacon.

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 |

Table 2. Effects of plant part and greenhouse condition on the sprouting rates in yacon.

| Plant part | Greenhouse condition† | Days after planting | | | | | |
|---|---|---|---|---|---|---|---|
| | | 5 | 10 | 15 | 20 | 25 | 30 |
| Crown | Open field | 0 | 0 | 0 | 0 | 0 | 0 |
| | Single | 0 | 0 | 2 | 10 | 34 | 86 |
| | Double | 0 | 6 | 8 | 60 | 94 | 100 |
| Shoot | Open field | 0 | 0 | 0 | 0 | 6 | 20 |
| | Single | 0 | 8 | 70 | 98 | 100 | 100 |
| | Double | 0 | 72 | 100 | 100 | 100 | 100 |

† Single:single-layer polyethylene-covered greenhouse, Double:double-layer polyethylene-covered greenhouse.

gation in *A. konjac*.

At 30 days after planting, any crown buds couldn't sprout in the open field while 86% of crown buds sprouted in the single-layer polyethylene-covered greenhouse and 100% sprouted in the double-layer polyethylene-covered greenhouse (Table 2), indicating that air temperature is an important factor for sprouting from crowns. When shoots reached to 2~3 cm long, they were separated from crowns and then planted (Photo. 1). Only 20% of shoots had new shoots in the control (open field) at 30 days after planting while 98% in the single-layer polyethylene-covered greenhouse at 20 days after planting and 100% in the double-layer polythylene-covered greenhouse at 15 days after planting. When seedlings were grown in the double-layer polyethylene-covered greenhouse, they can be planted from early May to late April. It means that planting shoots after sprouting can reduce the seedling period by about 30 days. When seedlings are grown in the single-layer polyethylene-covered greenhouse, the seedling period can be shortened by about 15 days.

The mean air temperature in the single-layer polyethylene-covered greenhouse was 23.8℃ during the experiment, which was higher with 5.2℃ than that in the open field (18.6℃). The mean temperature in the double-layer polyethylene-covered greenhouse was 28.0℃, which was higher with 9.4℃ than that in the open field (Fig. 3). Especially, the temperature in the single-layer polyethylene-covered greenhouse was 22.5℃ at the beginning of the experiment, which was higher with 8.5℃ than that in the open field (14.0℃), and the temperature in the double-layer polyethylene-covered greenhouse was 31.0℃ at the same period, which was higher with 17.0℃ than that in the open field.

### Plug seedlings proliferation

When crowns were planted in the single- or double-layer polyethylene-covered greenhouses, seedlings with 6 cm in plant height, 5 leaves and 6 roots were appropriate for use. There was no significant difference for seedling growth between in the single- and double-layer polyethylene-covered greenhouses. However, crowns not budded in the open field. In the case of planting shoots for seedlings, crown buds are need to be planted in the single- or double-layer polyethylene-covered greenhouses

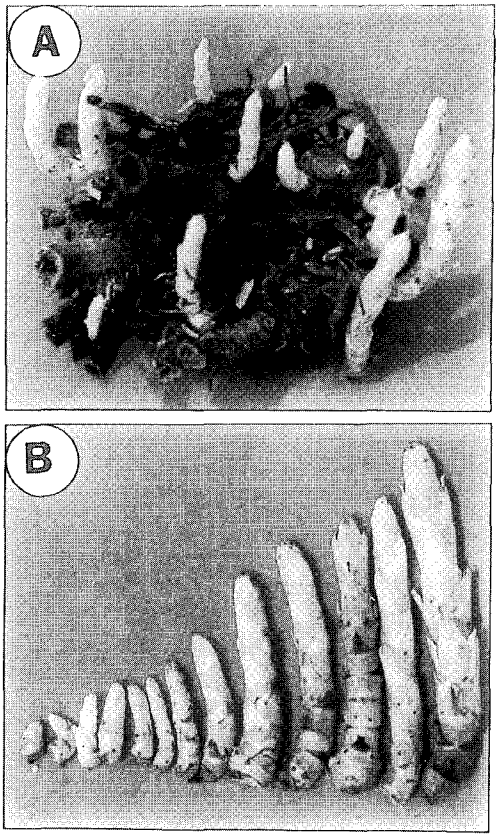


Photo. 1. Sprouting of crown at 25±1℃, in the dark condition at 30 days after treatment (A), and shoots separated from crowns in yacon (B).

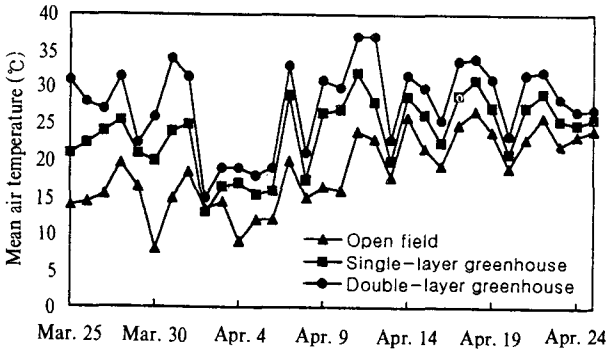


Fig. 3. Changes of air temperature in open field, single- and double-layer polyethylene-covered greenhouses during growing season of yacon in 1996. Air temperature was measured on 10 a.m. for each day.

Table 3. Effects of plant part and greenhouse conditions on the seedling growth at 30 days after planting in yacon.

| Plant part | Greenhouse conditions† | Plant height (cm) | Leaf | | | Root | | No. of nodes | Stem diameter (cm) |
|---|---|---|---|---|---|---|---|---|---|
| | | | No. | Length (cm) | Width (cm) | No. | Length (cm) | | |
| Crown | Open field | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Single | 6.0 | 4.7 | 3.0 | 1.4 | 6.0 | 7.3 | 3.0 | 0.4 |
| | Double | 5.5 | 5.3 | 3.6 | 2.0 | 6.3 | 8.4 | 2.7 | 0.4 |
| LSD (0.05) | | 1.2 | 0.7 | 0.9 | 0.4 | 1.6 | 0.9 | 0.8 | 0.1 |
| C.V. (%) | | 13.4 | 9.6 | 17.9 | 16.5 | 13.4 | 8.0 | 19.6 | 21.7 |
| Shoot | Open field | 1.4 | 2.7 | 0.9 | 0.5 | 3.3 | 1.9 | 1.7 | 0.3 |
| | Single | 5.6 | 6.0 | 3.5 | 1.7 | 6.7 | 6.8 | 3.0 | 0.4 |
| | Double | 10.3 | 8.0 | 8.5 | 3.9 | 13.3 | 7.7 | 4.0 | 0.6 |
| LSD (0.05) | | 1.8 | 1.1 | 1.9 | 0.3 | 2.1 | 1.1 | 1.4 | 0.2 |
| C.V. (%) | | 13.9 | 8.4 | 19.5 | 5.7 | 11.8 | 9.0 | 21.1 | 15.8 |

† Single:single-layer polyethylene-covered greenhouse, Double:double-layered polyethylene-covered greenhouse.

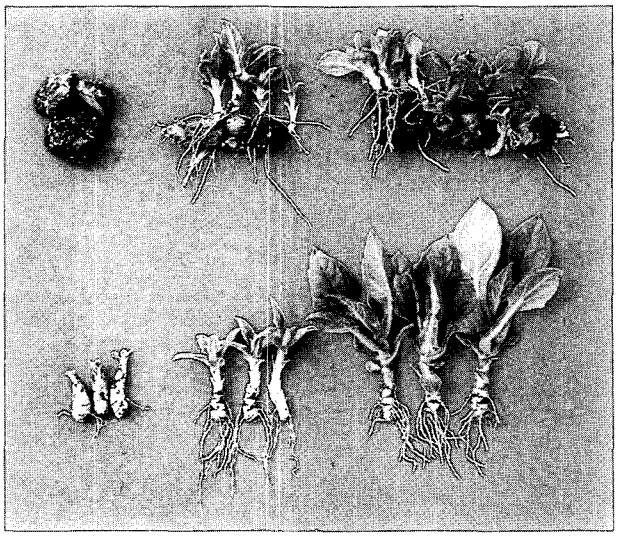

Photo. 2. Types of sprouting and growth from crowns (top) and shoots (bottom) in yacon, respectively.
Left:open field, Center:single-layer polyethylene- covered greenhouse, Right:double-layer polyethylene-covered greenhouse.

to reduce the period of seedling growth (Table 3, Photo 2). When shoots separated from crowns after sprouting were planted in the plastic trays, they could not be used as seedlings in the open field because seedlings had poor growth. However, they were suitable as seedlings for the growth in single- or double-layer polyethylene-covered greenhouses. Especially, grown seedlings in the double-layer polyethylene-covered greenhouse was 10 cm in plant height, 8 leaves and 13 roots, they were very good for use. There was no significant difference for seedling growth between crown and shoot in the single-layer polyethylene-covered greenhouses. Double-layer polyethylene-covered greenhouse, thus, was effective for seedling at early.

Bed soil is very important to produce plug seedlings. In the bed soil composed of clay loam and Compost (1:1=v:v) was best to produce yacon plug seedlings. Also, the mixture with sand and Compost (1:1=v:v) was good as the bed soil. Grown seedlings in the both bed soils were 6~7 cm in plant height, 12~13 leaves and roots (Table 4, Photo 3). Soil mixtures of clay loam and Compost or those of sand and Compost (1:1=v:v) were satisfied in a great degree for the requirements of optimistic bed soil which need good moisture holding ability, air permeability, little physical changes and stability of chemical component. By using our methodologies, the plug seedlings can be produced in the double-layer polyethylene-covered greenhouse within 30 days after planting.

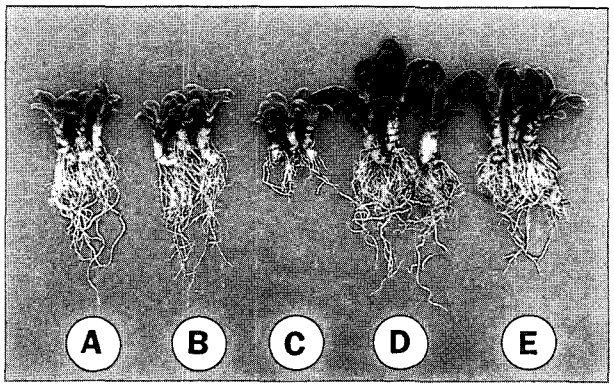


Photo. 3. Types of yacon seedlings from shoots planted in various bed soils.
(A):clay loam, (B):sand, (C):Compost, (D):clay loam: Compost=1:1(v:v), (E): sand:Compost=1:1 (v:v).

Table 4. Effects of various media on morphological traits of yacon seedlings at 30 days after planting shoots.

| Rooting media | Plant height (cm) | Leaf | | | Root | | No. of nodes /seedling | Stem diameter (mm) |
|---|---|---|---|---|---|---|---|---|
| | | No. | Length (cm) | Width (cm) | No. | Length (cm) | | |
| Clay loam (CL)† | 4.2 | 6.7 | 1.9 | 1.6 | 9.0 | 12.4 | 3.3 | 5 |
| Sand | 3.9 | 7.3 | 1.8 | 1.8 | 9.3 | 12.7 | 3.7 | 5 |
| Compost‡ | 3.9 | 9.3 | 1.6 | 1.3 | 9.7 | 6.9 | 4.7 | 8 |
| CL+Compost | 6.7 | 12.0 | 3.0 | 2.5 | 12.0 | 13.2 | 6.0 | 7 |
| Sand+Compost | 6.3 | 13.3 | 2.1 | 2.7 | 13.3 | 12.4 | 6.7 | 10 |
| LSD (0.05) | 0.1 | 1.9 | 0.7 | 0.2 | 0.9 | 1.2 | 0.6 | 1.0 |
| C.V. (%) | 1.1 | 10.1 | 18.0 | 5.2 | 4.6 | 5.7 | 6.7 | 8.3 |

## ACKNOWLEDGMENTS

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