Korean J. Crop Sci. 46(1): 35~39(2001)

Effect of Holding Period of Cutting on Sprouts Quality and Sweet Potato Growth

Kwang Ho Cha*, Byeong Gook Lee*, Nam Hee Yoo,***† Song Joong Yun*,** and Kyeong Gu Choi*,****

*Department of Agronomy, Graduate School of Chonbuk National University, Chonju 561-756, Korea
**Institute of Agricultural Science & Technology, Chonbuk National University, Chonju 561-756, Korea
***Institute of Biotechnology, Greenbiotech Co., Ltd., Paju, 413-830 Korea

ABSTRACT: It is important to accelerate rooting and establishment of seedlings after transplanting for higher dry matter production and tuber yield in sweet potato cultivation. Therefore, this study was conducted to obtain some information about the effects of vine-cutting holding on rooting and plant growth after transplanting. Vines were cut 20~25 cm long and stored for 1, 3, 5, 7 or 9 days in a shade room at 20 ± 0.5°C, RH 68 ± 1%. Peroxidase activity in the vine cuttings increased as the holding period increased and the highest catalase activity was detected in the 5-day holding. Length of main vine, number of branches and nodes on main vine also increased in the 5-day holding. There was little difference in the diameter of main vine among the various holding periods. The data obtained indicate that transplanting of vine cuttings after 5-day holding could promote rooting and vine growth.

Keywords : vine cuttings, effect of holding, sweet potato, rooting, peroxidase, catalase

Sweet potato is a crop that has potential to produce largest dry matter per unit area. Sweet potato also contains phytochemicals of nutritive and functional benefits, so it has great potential as resources for favorite and functional foods (Kim *et al.*, 1995; Ravindran *et al.*, 1995). Cultivation of sweet potato, however, need much efforts such as raising seedlings and transplanting. Furthermore, the suitable season for transplanting is dry and busy for rice farming causing competition for labor. Dry weather may cause poor rooting and plant establishment after transplanting of vine cuttings.

Quality of vine cuttings is very important in potato cultivation because it directly influence on rooting and plant growth. There are mixed results on the effects of holding of vine cuttings. Higher tuber yield was obtained when the vine cuttings were planted right after cutting no later than the latter part of May. And no tuber yield decrease was observed with up to 3-day holding of vine cuttings before transplanting (Agricultural Demonstration Station (ADS), 1918). But several reports indicated that holding of vine cuttings before transplanting increase plant growth and yield. Nakatani et al (1987) and Jeong (1996) reported that planting of vine cuttings after 5- to 10-day holding increases yield compared with planting right after preparation of vine cuttings. Yield increased 2% with 5- to 10-day storage of vine cuttings but decreased 1% with 15-day storage (ADS, 1918).

More research is required to address variable results on the effects of holding conditions on yield and lack of information on the physiological changes in vine cuttings during holding. This work was carried out to examine the effects of holding period on rooting and plant growth as well as on biochemical changes of vine cuttings during storage.

MATERIALS AND METHODS

Plant materials and holding treatments

Tubers of Zami (Mokpo 29) and Sinhwangmi (Mokpo 30), which were obtained from Mokpo Experiment Station, Rural Development Administration (RDA) in 1999 were planted on a fermentation hot bed maintained at 30 ± 0.5°C on Feb. 20 in 2000. Vines after 90 days of planting were used for the preparation of vine cuttings. Vines were cut 20~25 cm long and stored for 1, 3, 5, 7 or 9 days in a shade room at 20 ± 0.5°C, RH 68 ± 1%.

Soil analysis and field preparation

Soil of the experimental field (Ilim village, Myoungduk-li, Soyang-myeon, Wanju-gun, Korea) was analyzed according to soil analysis method (RDA, 1983). Physical and chemical characteristics of soil were as in Table 1. Average pH was 6.3 and organic-matter content was 2.15% that is higher than the average of Korean upland soil (Hwang *et al.*, 1997; Hong *et al.*, 1972).

Field rows were prepared three weeks before planting by

†Corresponding author: (Phone) +82-63-270-2508 (E-mail) nhyoo5@yahoo.co.kr
<Received February 1, 2001>

Table 1. Physical and chemical properties of soil in the experimental field.

pH (1:5H_2O)	O.M (%)	T-N (mg/kg)	T-P (mg/kg)	Ex. cations (cmol/100 g)				C.E.C (cmol/100 g)	Soil texture
				K	Na	Ca	Mg		
6.3	2.15	1154.3	400.0	1.25	1.75	3.87	2.25	9.88	C.L

plowing after total layer application of fertilizer, N-P_2O_5-K_2O : 2.7-6.8-19.8 (kg/10 a) and mulching with black plastic film.

Enzyme activity assay

Vine cuttings were ground under liquid N_2, and one gram of tissue powder was homogenized with 3 ml of the extraction buffer and 40 mg of polyvinylpolypyrrolidone in a chilled mortar and pestle. The homogenate was centrifuged at 12,000 *g* for 20 min and the resulting supernatant was used as protein source. Protein contents were determined by the method of Bradford (1976) with bovine serum albumin as a standard.

The protein extracts prepared for protein analyses were also used for peroxidase activity assay. Protein extracts for catalase were prepared by the same procedure except the dithiotreitol (DTT) which was substituted for β-mercaptoethanol. Thirty μg proteins in the extracts were used for activity analysis otherwise indicated. Peroxidase activity was assayed in a reaction mixture consisting of 50 mM potassium phosphate, pH 6.4, 0.3 mM guaiacol, 0.14 mM H_2O_2 as described by Chance and Maehly (1955). Catalase activity was assayed by determining the rate of change in the absorbance at 240 nm in a reaction mixture consisting of 50 mM potassium phosphate, pH 6.9, 11.6 mM H_2O_2 and 10 mM DTT at 25°C (Beers and Sizer, 1952).

Rooting and growth analysis

After the holding, the apical and basal parts of the vine cuttings were cut into smaller vine cuttings to contain 3 internodes. The smaller vine cuttings were planted in 7 cm diameter plastic pots filled with peat moss and grown in a glass house maintained at 27 ± 2°C, RH 58 ± 1%. Rooting and root growth were examined 14 days after transplanting.

After holding treatment, the vine cuttings (approximately 20-25 cm, 25 g and containing 6-7 nodes) were transplanted in the field. The vine cuttings were planted at 70 cm× 30 cm spacing on May 27 in 2000. Ten cuttings were planted per treatment with 3 replications at randomized block design and irrigated immediately after planting. Growth characteristics were determined 3 times from 30 days after planting at 15-day intervals. At harvest, length of vine was determined according to the examination protocol for agricultural experiments from RDA (1995).

RESULTS AND DISCUSSION

Effects of holding on peroxidase and catalase activity

Peroxidase activities in 1-day holding were 26.7 and 17.7 mol/μg protein for Sinhwangmi and Zami, respectively. Activity in Sinhwangmi was 9 mol/μg higher than that in Zami (Fig. 1). As the holding period increased, the peroxidase activities increased especially in Sinhwangmi. In 9-day holding treatment, the activity was 267 and 232% higher compared with that in 1-day holding treatment in Sinhwangmi and Zami, respectively. Similar increase in peroxidase activity was reported in tobacco plants under non-biological stresses such as dryness, high salinity, wounding and air-pollutants (Yun, 1998).

Catalase activities increased as the holding period increased up to 5 days and the activities decreased after 7-day holding.

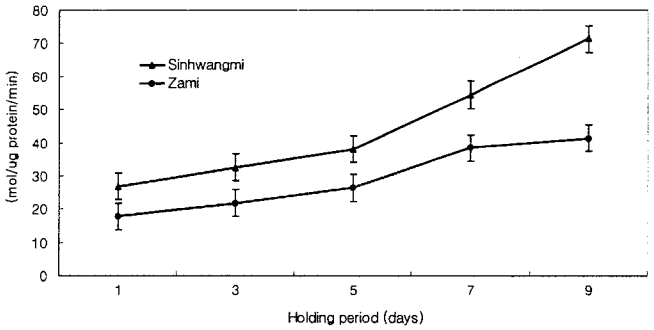

Fig. 1. Changes in peroxidase activities in vine cuttings under the various holding periods.

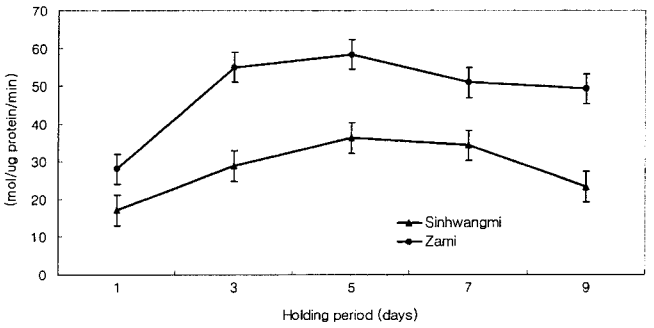

Fig. 2. Changes in catalase activities in vine cuttings under the various holding periods.

The activities in 5-day holding were about 2-fold higher than those in 1-day holding to be 36.3 and 58.2 mol/μg protein in Sinhwangmi and Zami, respectively (Fig. 2).

Pattern of catalase activity was different from that of peroxidase in that the activity increased as the holding period increased up to 5 days but decreased thereafter. Contrary to the peroxidase activity, the catalase activity was higher in Zami than in Sinhwangmi.

Effects of holding on rooting and vine growth

Fresh weight of vine cuttings decreased as the holding period increased. Fresh weight under 5-day holding was 51.9 and 43.8% of that under 1-day holding treatment in Sinhwangmi and Zami, respectively (Fig. 3). Reduction rate of fresh weight of Zami was higher than that of Sinhwangmi.

The effects of holding periods on rooting on the transplanted vine cuttings are shown in Table 2 and Fig. 4. In 1-day holding treatment, length of root, number of root, fresh weight of root on apical part of vine cuttings were 2.86 cm, 5 ea and 1.6 g, respectively, with no deciduous leaves. Those values increased till 5-day holding treatment. These are similar to Nakatani's results in that 5- to 10-day holding treatment were effective for rooting and tuber root formation (Nakatani *et al.*, 1987). Taken together, 5-day holding treatment was better for rooting and root growth on transplanted vine cuttings than any other holding treatments.

Length of main vine of Sinhwangmi 30 days after transplanting was 76.5, 88.6, 96.2, 92.7 and 45.8 cm for 1, 3, 5, 7, 9 days of holding treatment, respectively. Vine length was longer in 5- to 7-day holding treatment (Table 3). Length of main vine 45 days after transplanting was similar to that 30 days after transplanting. Similar effects of holding on vine

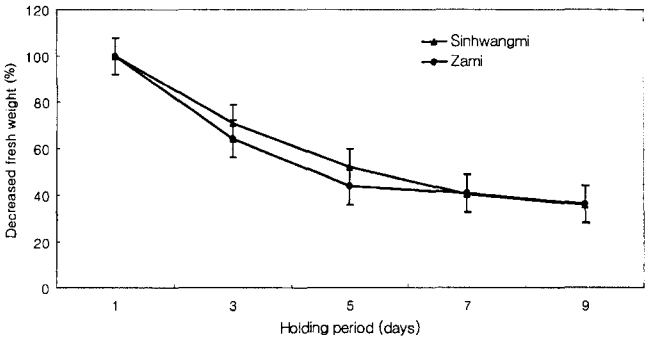

Fig. 3. Changes in the fresh weight of vine cuttings under the various holding periods.

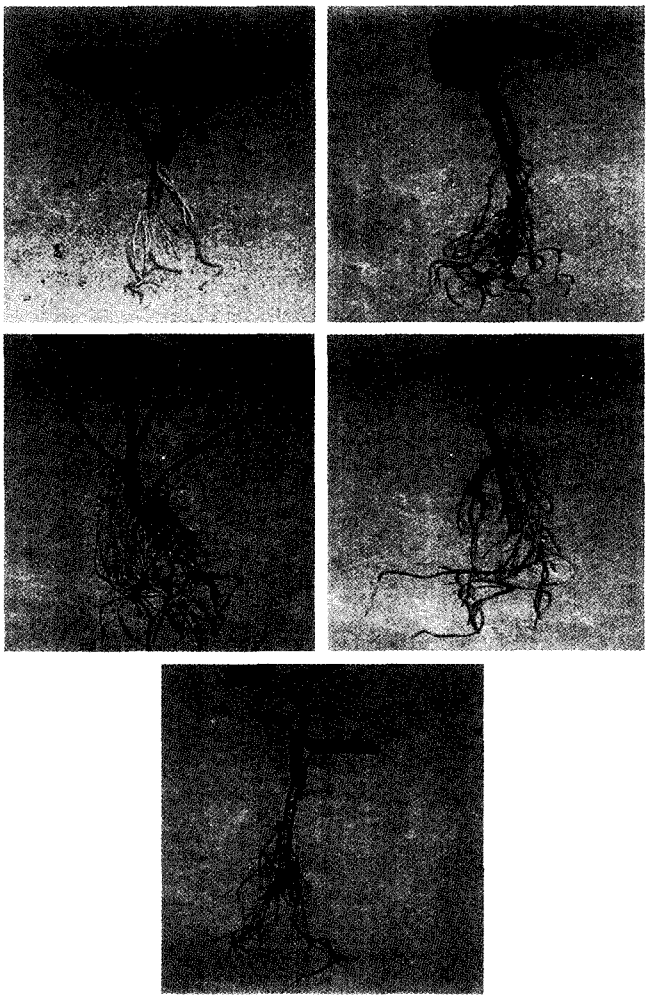

Fig. 4. Effects of apical part on the vine cutting under the various holding periods on rooting in Sinhwangmi.

Table 2. Changes in rooting ability of vine cuttings under the various holding periods in Sinhwangmi.

HP	1		3		5		7		9	
Part	A	B	A	B	A	B	A	B	A	B
NDL (unit)	0	0	0	1	0.5	1.3	1	1.5	1.3	2
LR (cm)	2.86	5.34	3.46	5.58	6.09	7.21	5.37	4.84	5.86	3.67
NR (unit)	5	23	7	22	13	27	24	9	20	11
FWR (g)	1.6	5.6	2.2	6.1	3.9	9.2	5.8	3.6	5.7	1.4

HP : Holding periods, Part : Position of vine cuttings, NDL : Number of deciduous leaves, LR : Length of root, NR : Number of roots, FWR : Fresh weight of root, A : Apical part of vine cuttings, B : Basal part of vine cuttings.

Table 3. Effects of the various holding periods of the vine cuttings on vine growth in Sinhwangmi.

HP	1		3		5		7		9		C.V (%)	F	L.S.D	
DT (days)	30	45	30	45	30	45	30	45	30	45			5%	1%
LMV (cm)	76.5 (100)†	159.9 (209)	88.6 (115.8)	150.2 (196.3)	96.2 (125.8)	173.7** (227.1)	92.7 (121.1)	169.9 (222.1)	45.8 (59.9)	125.7 (164.3)	9.16	18.07**	12.78	16.99
NB (units)	5.6 (100)	7.4 (132)	5.5 (98.2)	8.3 (148.2)	6.4 (114.3)	8.6 (153.6)	6.5 (116)	7.5 (133.9)	3.7 (66.1)	6.0 (107.1)	20.99	4.07**	1.41	1.88
NNMV (units)	23.1 (100)	33.1 (143.3)	24.6 (106.5)	33.5 (145.0)	24.1 (104.3)	37.6 (162.8)	25.4 (109.9)	35.4 (153.2)	18.5 (80.1)	27.4 (118.2)	16.52	4.74	4.93	6.56
DMV (cm)	0.508 (100)	0.529 (104.1)	0.521 (102.6)	0.533 (104.9)	0.525 (103.3)	0.528 (103.9)	0.506 (99.6)	0.524 (103.1)	0.496 (97.6)	0.525 (103.3)	7.352	20.681*	0.044	0.058

†Percentage reference value at 30 days after transplanting.
HP : Holding periods, DT : Days after transplanting, LMV : Length of main vine, NB : Number of branches, NNMV : Number of nodes on main vine, DMV : Diameter of main vine.

Table 4. Effects of the various holding periods of the vine cuttings on vine growth in Zami.

HP	1		3		5		7		9		C.V (%)	F	L.S.D	
DT (days)	30	45	30	45	30	45	30	45	30	45			5%	1%
LMV (cm)	72.2 (100)†	169.1 (234.2)	68.5 (94.8)	169.6 (234.9)	71.9 (99.5)	180.2 (249.6)	67.6 (93.6)	169.3 (234.4)	56.2 (77.8)	151.0 (209.1)	22.78	1.08	33.93	45.13
NB (units)	1.9 (100)	7.6 (400)	2.2 (115.8)	10.8* (564.8)	3.3 (173.6)	7.6 (400)	1.78 (93.6)	5.6 (294.7)	0.6 (31.6)	4.8 (252.6)	25.55	7.81**	2.45	3.34
NNMV (units)	18.8 (100)	31.5 (167.7)	18.5 (98.4)	31.8 (169.1)	19.4 (103.2)	33.4 (177.7)	16.3 (86.7)	30.4 (161.7)	14.2 (75.5)	27.4 (145.7)	11.65	1.93	4.75	6.48
DMV (cm)	0.274 (100)	0.285 (104)	0.271 (98.9)	0.297 (108.4)	0.298 (108.8)	0.345* (125.9)	0.278 (101.5)	0.313 (114.2)	0.267 (97.4)	0.281 (102.6)	7.352	0.11**	0.029	0.039

†Percentage reference value at 30 days after transplanting.
HP : Holding periods, DT : Days after transplanting
For other abbreviations, see Table 3.

growth was reported by Nakatani *et al.* (1987). Similar effects of holding was observed in number of nodes and number of branches on main vine as in length of main vine.

Length of main vine of Zami 30 days after transplanting was 72.2, 68.5, 71.9, 67,6 and 56.2 cm for 1, 3, 5, 7, 9 days of holding treatment, respectively (Table 4). Little difference in main vine length was observed except at 9-day holding treatment. Main vine length in 45 days after transplanting was similar to that in 30 days after transplanting except in 5-day holding treatment where main vine length was longer than in any other treatments.

However, moderate difference was observed in number of branches between the treatments. Number of branches 30 days after transplanting was 1.9 in 1-day holding compared to 3.3 in 5-day holding. Similar tendency of holding effect was observed in number of nodes on main vine and diameter of main vine. Taken together, best vine growth was observed in 5-day holding treatment.

The results indicate that holding of vine cuttings 3 to 5 days promotes rooting and plant growth. Therefore, vine cuttings can be stored 3 to 5 days without yield loss in case transplanting of vine cuttings is not allowed right after preparation due to weather conditions or labor competition.

It is of interest to examine the physiological and biochemical mechanisms of stimulatory effects of holding on vine cuttings.

ACKNOWLEDGMENT

A part of this work was supported by the research fund from Chonbuk National University in 2000.

REFERENCES

Agricultural Demonstation Station. 1918. Storage period comparison and cutting seedling test. The trial report.

Beers, R. F. and I. W. Sizer. 1952. A spectrophotometric method for measuring the breakdown of hydrogen peroxidase by catalase. *J. Biol. Chem.* 195 : 133-140.

Bradford, M. M. 1976. A rapid and sensitive method for the quan-

titation of microgram quantities of protein utilizing the principle of protein-dye binding. *Anal. Biochem.* 72 : 248-254.

Chance, B. and A. C. Maehly. 1955. Assay of catalase and peroxidase. *Methods Enzymol.* 2 : 764-775.

Hong, C.W. 1972. Soil fertility status in soil of Korea. ASPAC. Technical Bull, Fftc, Taiwan 10 : 56-84.

Hwang, K.S., Lee, S.J., Kwak, Y.H. and Kim, K.S. 1997. Soil chemical properties of major vegetable producing open fields. *J. Korean Soc. Soil Fert.* 30(2) : 146-151.

Jeong, B. C. 1996. Effects of preliminary treatments on vine cuttings before transplanting on growth and yield in sweet potato. *RDA J. Agri. Sci. Technol.* 28 : 345-351.

Kim, S. Y. and Ryu, C. H. 1995. Studies on the nutritional components of purple sweet potato (*Ipomoea batatas*). *Korean J. Food Sci. Technol.* 27 : 819-825.

Nakatani, M., Oyanagi, A. and Watanabe, Y. 1987. Holding of cutsprouts in sweet potato (*Ipomoea batatas* Lam.). *Japan. J. Crop Sci.* 56(2) : 238-243.

Ravindran, V., Ravindran, G., Sirakanesan, R. and Rajaguru, S. B. 1995. Biochemical and nutritional assessment of tubers from 16 cultivars of sweet potato. *J. Agric. Food Chem.* 43 : 2646-2651.

RDA. 1983. Soil chemical analysis. RDA.

RDA. 1995. The examination protocol for agricultural experiment 540-552. RDA.

Yun, B. W. 1998. Characterization of transgenic tobacco plants overexpressing sweet potato peroxidase in terms of environmental stresses. Graduate school, Kyungpook National University.