

Efficient Production of Ginger (*Zingiber officinale* Roscoe) Rhizome by Shoot-Tip Culture

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Abstract - High productivity of ginger (*Zingiber officinale* Roscoe) was obtained from the rhizome produced by shoot-tip culture with Korean native variety, Seosanjong. Seed rhizomes induced by shoot-tip culture were successfully established in the field. The rhizomes induced by both plant or rhizome were higher in emergence rate and faster in days to emergence than those of home seed production. The seed rhizome production induced by shoot-tip culture was two times heavier than that of home seed production. These results suggest that shoot-tip culture might be one of mass propagation methods in seed rhizome of ginger plant.

Key words - Korean native ginger, Propagation, Seed rhizome, Tissue culture

Introduction

Ginger is a monocotyledonous perennial herb, an important tropical crop, has been used around the world as a condiment and also for its medicinal materials. Important ingredients contained are zingerone, shogaol, gingerol, refined oil and other things of ginger rhizomes. It is exclusively propagated vegetatively by rhizomes (Kim *et al.*, 1991). Because ginger does not produce seeds, it is very difficult to breed new genotypes through sexual propagation (Adaniya and Shoda, 1998). Thus, most of the crop improvement programmes of this species are confined to evaluation and selection of naturally occurring clonal variations.

Biotechnological approaches for crop improvement require efficient regeneration of crops from tissue culture. Ginger is mostly confined to propagation from shoot-tip culture (Choi and Kim, 1991; Noguchi and Yamakawa, 1988; Roh *et al.*, 1996). In a vegetatively propagated crop like ginger, the risk of systemic infections with rootknot nematodes, bacterial wilt, virus and *Fusarium* from the propagules are remarkably high. De Lange *et al.* (1987) successfully eliminated rootknot nematodes from heavily infected rhizomes through *in vitro* culture of shoot tips. Malamug *et al.* (1991), Kackar *et al.* (1993), and Jo *et al.* (2000a) have also reported plant regeneration by

organogenesis in ginger. Jo *et al.* (2000b) also suggested efficient propagation using bioreactor system of Korean native ginger. In this study, we report efficient production of seed rhizome induced by tissue culture of Korean native Seosanjong of ginger (*Zingiber officinale* Roscoe). We also demonstrate the importance of shoot-tip culture in seed rhizome production.

This study has been undertaken to demonstrate the efficient propagation of rhizome induced by tissue culture in producing normal rhizome in ginger.

Materials and Methods

Seed rhizome (20~30 g) with 2 or 3 buds used in this experiment and rhizomes induced by *in vitro* regenerated plantlet through shoot-tip culture of Korean native Seosanjong of ginger (*Zingiber officinale* Roscoe).

A field study was conducted in 13th May 2004 to 20th October 2004 at the Research Field of Horticultural Research Division, Chungcheongnam-do Agriculture Research and Extension Services through cultivation under rain shelter. Plots were 20 m long with 40 cm between beds, on a raised bed (120 cm width × 15 cm height). Forty eight seed rhizomes were planted in 30 × 50 cm apart four rows per plot for each treatment. Plots were arranged in a completely randomized

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design with four replications. Ginger grown at cultivation under rain shelter were harvested on 20th October 2004 for measurements. Plant height, bulb number, bulb weight, total fresh weights were determined from five plants in each plot. Differences among mean values were tested by Duncan's multiple range test.

Results and Discussion

The effect of tissue cultured rhizomes of ginger on shoot emergence is presented in Table 1. In tissue cultured rhizomes and vegetatively propagated rhizomes, tissue cultured rhizome was the most effective in early emergence and percentage of

emergence. At the best emergence rate, TC2F was 92.1%.

The frequency of emergence ranged from 77.3% to 92.1% in tissue cultured rhizome while vegetatively propagated rhizomes was ranged up to 36.6%. Thus the present results showed that tissue culture derived rhizomes was more vigorous than home seed production in production of seed ginger. Early of emergence was noticed from a tissue cultured rhizomes than a Korean native ginger rhizomes.

The agromatic characteristics of rhizome were dependent on seed rhizome in ginger (Table 2). Plant height of TC1F was highest among all treatments. The stem number per a plant in TC2H was significantly higher than other treatments. The stem diameter of plant in TC1F was highest while that of TC1H was lowest. The fresh weight of rhizome per a plant after harvesting

Table 1. Effect of seed rhizome produced by shoot-tip culture and vegetative propagation on shoot emergence of Korean native Seosanjong of *Zingiber officinale* Roscoe

Materials	First date to emergence	Final date to emergence	Emergence rate (%)	Periods from planting to emergence (days)
TC1F ^z	Jun. 1	Jun. 14	84.3	32
TC1H	Jun. 1	Jun. 14	77.3	32
TC2F	Jun. 1	Jun. 14	92.1	32
TC2H	Jun. 1	Jun. 14	78.0	32
SRVP	Jun. 14	-	36.6	45

^zTC1F: seed rhizome obtained from rhizome induced by shoot-tip culture grown in the field; TC1H: seed rhizome obtained from rhizome induced by shoot-tip culture grown in the greenhouse; TC2F: seed rhizome obtained from plant induced by shoot-tip culture grown in the field; TC2H: seed rhizome obtained from plant induced by shoot- tip culture grown in the greenhouse; SRVP: seed rhizome obtained from vegetative propagation.

Table 2. Effect of seed rhizome produced by shoot-tip culture and vegetative propagation on agromatic characteristics of Korean native Seosanjong of *Zingiber officinale* Roscoe

Materials	Plant height (cm)	Stem number (No./plant)	Stem diameter (mm)	F.W. of rhizome ^z (g/plant)
TC1F ^y	92a ^x	15c	11a	486a
TC1H	67b	24b	8b	283b
TC2F	62b	35a	9b	352b
TC2H	69b	36a	9b	363b
SRVP	60b	17bc	10ab	166c

^zData were investigated on 20th October after harvesting.

^yTC1F: seed rhizome obtained from rhizome induced by shoot-tip culture grown in the field; TC1H: seed rhizome obtained from rhizome induced by shoot-tip culture grown in the greenhouse; TC2F: seed rhizome obtained from plant induced by shoot-tip culture grown in the field; TC2H: seed rhizome obtained from plant induced by shoot-tip culture grown in the greenhouse; SRVP: seed rhizome obtained from vegetative propagation.

^xMean separation within columns by Duncan's multiple range test at 5% level.



Fig. 1. Comparision of ginger rhizome between shoot-tip culture and vegetative propagation at planting and harvesting time of Korean native Seosanjong of *Zingiber officinale* Rosc. **A:** seed rhizome of rhizome induced by shoot-tip culture grown in the field (TC1F); **B:** seed rhizome of plant induced by shoot-tip culture grown in the field (TC2F); **C:** harvested normal ginger of shoot-tip cultured rhizome (TC2F); **D:** harvested ginger of vegetatively propagated rhizomes Korean native Seosanjong of *Zingiber officinale* Roscoe (SRVP). Bar is 5 cm.

per plant was more than 2 times compared to Korean native ginger. The rhizome induced by tissue culture was more efficient in producing 486 g fresh weight per plant compared with vegetative propagation method. The weights of seed rhizome per a plant were significantly higher with a tissue cultured rhizomes than vegetatively propagated rhizomes.

The growth and seed rhizome in ginger have shown in Fig. 1. Seed rhizomes through shoot-tip of Korean native Seosanjong of *Zingiber officinale* Rosc. obtained in present study was by incubation of shoot-tip explants for 4 months on MS medium supplemented with 0.5 mg/L NAA and 0.5 mg/L BA (Fig. 1A and B). The optimal concentration of NAA and BA on growth of *in vitro* plantlet was confirmed by Choi and Kim (1991). The seed rhizomes were transferred to cultivation under rain shelter.

In air temperature sequence during the growth period, 30/22°C factor affected strongly to initial growth stage and accelerated rhizome formation on rhizome enlargement (Hyun *et al.*, 1997). We harvested a better seed gingers from shoot-tip cultured rhizomes (Fig. 1C) than vegetatively propagated rhizomes (Fig. 1D). Ginger growth and production of *in-vitro* mass propagated rhizomes were excellent compared to vegetatively propagated rhizomes after cultivation under rain shelter.

These results showed that the production of rhizomes induced by tissue culture were better than vegetatively propagated rhizomes. It is also supported by the previous report that the mass production of rhizome induced by tissue culture was obtained in ginger (Cho *et al.*, 1997; Hyun *et al.*, 1997).

The *in vitro* regenerated plants using shoot-tip culture were

phenotypically normal and were transferred to field conditions completing the biological cycle after 5 months with growth and seed rhizome formation. The plants and rhizomes obtained by shoot-tip culture increased significantly both growth and yield when compared to vegetatively propagated rhizomes. The rhizome using tissue culture was effective in the seed ginger production. Further research should be required to understand various factors associated with the systematical establishment of ginger.

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