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Influence of Cultivation Period on Seed Bulb Production of Korean Native *Allium wakegi* Araki

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ABSTRACT

Optimmum cultivation period was determined for producing seed bulb of Korean native *Allium wakegi* Araki in vitro in hydroponic culture. The growth gradually increased during cultivation period. In general, plants grown for 5 months produced significantly the highest bulb number and bulb fresh weight per plant. Raising the cultivation period from 1 to 5 months remarkably increased seed bulb yield.

Key word **:** *Allium wakegi* Araki, cultivation period, hydroponics, seed bulb

INTRODUCTION

For the character improvement of higher plants, breeding techniques based on conventional crossing, somaclonal variation, cell fusion and gene transfer are considered to be the useful methods. The successful application of these techniques remarkably depends upon the efficient crop production system in many crops.

Allium wakegi Araki (Araki, 1950) is a popular vegetable grown in China, Japan, and the southeast Asia for its mildly pungent bulbs and flavorful leaves. *Allium wakegi* has originated as a hybrid between *A. ascalonicum* and *A. fistuosum* (Tashiro, 1984). *Allium wakegi* is only propagated asexually, by planting bulbs, and is supposed to be developed into a vegetable population consisting of various clones over a long history of cultivation. Bulb formation of *A. wakegi* has been studied well on the effects of daylength, temperature, temperature experienced, and soil moisture (Ohkubo *et al.*, 1981; Yamazaki *et al.*, 2003). There is an increasing interest in *A. wakegi* as health vegetable. Recently, fresh plant production of *A. wakegi* in the Chungcheongnam-do, Jeollanam-do, and Gyeonggi-do area is expanding (NAQS, 2002). Demand is increasing due to the popularity of the Kimchi, spice, and medicine industry. Managing production inputs and minimizing production costs are increasingly important. Previously, we established an in-row plant spacing of Korean native *A. wakegi in vitro* (Jo *et al.*, 2003). Optimal cultivation period studies have not been conducted on *A. wakegi in vitro* in hydroponic culture under greenhouse. The main objective of this study was to determine the influence of cultivation period on plant growth, bulb development, and seed bulb production of *A. wakegi*.

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MATERIALS AND METHODS

A. wakegi plants derived from the shoot-tip culture were propagated in MS solid medium (Murashige and Skoog, 1962) including 1 mg/L 2iP. The pH of the medium was adjusted to 5.8 before autoclaving at 121 ℃ for 15 minutes. The shoot tip in culture tubes (Ø25 mm × 150 mm) were incubated at 25±1℃, 60℃, μ mol · m^{-2} · s^{-1} photosynthetic photon flux (PPF) for 2 weeks and then transferred to 500 ml culture bottle (Ø 66 mm × h 132 mm) with a 16-h light provided by white fluorescence lamps for 7 weeks.

A field study was conducted in 24th December 2002 to 26th May 2003 at the Research Farm of Bioenvironmental Division, Chungcheongnam-do Agriculture Research and Extension Services. Seedlings with 2 to 3 leaves cultured *in vitro* were planted on 24th December 2002 on a single in-row plant spacing were evaluated: 5 cm on Styrofoam beds (42.5 cm wide, 24.5 cm high, and 116 cm long) including a mixture of peatmoss: perlite: vermiculite (1:1:1=v/v/v) and placed in a plastic greenhouse. Plots were 10 m long with 91.5 cm between beds, on a raised beds (42.5 cm wide × 15 cm high). Twenty seedlings were planted in double rows (17.5 cm apart) per plot for each treatment. The artificial soil in the beds had been fertilized with 'standard nutrient solution of National Horticultural Research Institute, Rural Development Administration (RDA), Korea' (Park and Kim, 1998). Plots of *A. wakegi* were arranged in a completely randomized design with four replications. *A. wakegi* plants grown at 18~32℃ were harvested on 26th May 2003 for measurements. Plant height, leaf number, bulb number, bulb weight, total fresh weights were determined from four plants in each plot. Differences among mean values were tested by Duncan's multiple range test.

RESULTS AND DISCUSSION

Agronomic characteristics

Cultivation period influenced *A. wakegi* seed bulb production through shoot-tip derived plant by using hydroponic culture in greenhouse (Fig. 1 and Table 1). As cultivation period after planting increased from 1 to 5 months, leaf number, bulb number, bulb weight, and total fresh weight increased significantly. Plant height, however, was affected a little by cultivation period. The highest plant, leaf number, bulb number, and bulb weight were from plants produced at the longest cultivation period (5 months). The lowest leaf number, bulb number and bulb weight were from at the shortest cultivation period (1 month). All plant characteristics, other than plant height were influenced by cultivation period. Bulb number and bulb fresh weights per plant for plants cultivated at 5 months increased about 24 and 275 times than that of plants at the 1 month cultivation after planting, respectively. A low temperature period preceding the long daylength and high temperature phase served to fasten bulb formation (Ohkubo *et al.*, 1981). When bulbs were stored between 1 and 25℃ for 50 days and grown at 20℃ under a 13-hr photoperiod, storage at below 15℃ promoted the formation of new bulbs (Yamazaki *et al.*, 2003). Temperature of 20℃ more promoted bulbing in Allium cepa L. var. ascalonicum Backer and Allium × wakegi Araki than at 25 and 30℃ (Okubo *et al.*, 1999). Also, the results of the present study suggest that mean temperature (22℃), daylength and cultivation period affects bulbing formation and that these factors may be important in determining optimum seed bulb production.

Bulb fresh weight and total fresh weight per plant were highest at the longest cultivation period in our study. The result suggest that the seed bulb fresh weight per plant increase with a longer cultivation period is attributed by to a longer cultivation period. Song and Yang (2003) reported that vigorous vegetative growth resulted in the largest bulbs. Woo and Park (1980) concluded that growth and bulb formation of shallot

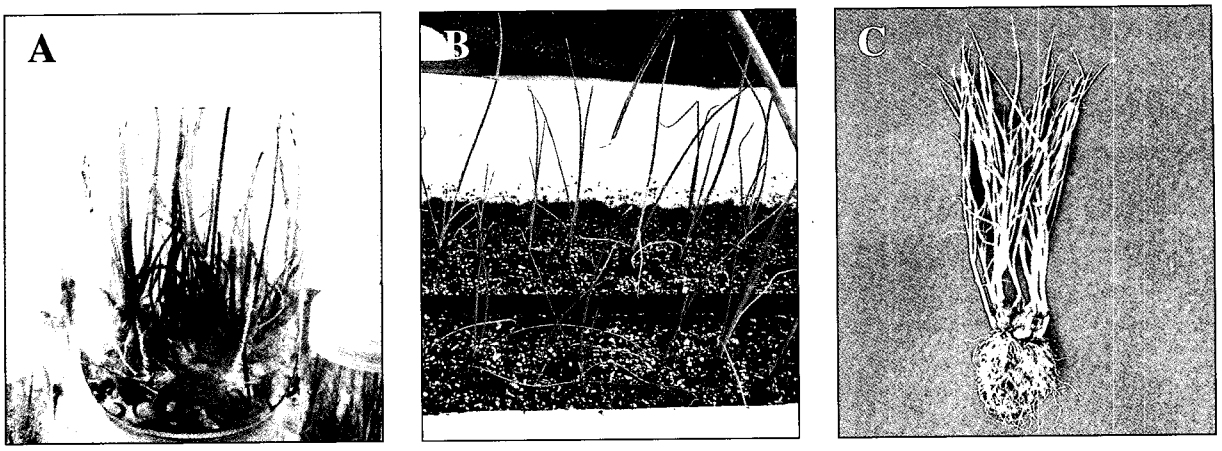

Fig. 1. Seed bulb production through shoot-tip derived plantlets using hydroponic culture in greenhouse of Korean native *Allium wakegi* Araki (A: multiple plantlet regeneration using shoot-tip culture; B: planting of regenerated plantlets in a hydroponic culture bed; C: seed bulb harvest after 5 months after planting).

Table 1. Comparison of agronomic characteristics in different cultivation period after planting of Korean native *Allium wakegi* Araki *in vitro*

Month	Plant height (cm)	No. of leaves (ea./plant)	No. of bulbs (ea./plant)	Bulb fresh weight (g/plant)	Total fresh weight (g/plant)
1st	28.2	5.0	1.0	0.3	1.1
2nd	36.9	10.7	2.0	2.2	11.6
3rd	40.1	27.5	4.5	8.8	33.5
4th	41.4	47.7	6.5	13.9	47.9
5th	45.8	105.0	24.0	82.6	164.1
Significance	*	***	***	***	***

*, *** Significant at $P = 0.05$ and 0.001, respectively.

plants (*Allium ascalonicum* L.) was remarkably affected by daylength. The bulb formation was promoted by long daylength in garlic plants (Aoba and Takaki, 1971). Our results indicate a similar trend; at longer cultivation period that is seed bulb production efficiency was highest.

Shorter cultivation period after planting resulted in plants were smaller and produced less bulb fresh weight per plant. These results indicate that cultivation period after planting longer than the 1 to 4 months cultivation period recommendation for Korean native *Allium wakegi* may be optimal growth and seed bulb production in hydroponic culture. As cultivation period increased from 1 to 5 months, seed bulb fresh weight per plant increased significantly. The lowest and highest fresh plant yields were for the plants grown at the 1 and 5 months cultivation period, respectively. The present data strongly suggest that seed bulb production by longer cultivation period is desirable for maximizing bulb number, bulb fresh weight, and yield. Further

studying is necessary to access the effects of cultivation type, field conditions, and various factors associated with the seed bulb production in Korean native *Allium wakegi* Araki.

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