Bulbing Response of Shallot (*Allium cepa* L. var. *ascalonicum* Backer) and *Allium* × *wakegi* Araki to Daylength and Temperature

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Summary

Bulbing response of two accessions of shallot and two accessions of *A.* × *wakegi* collected in Indonesia and two *A.* × *wakegi* accessions in Japan to daylength and temperature was investigated. All accessions formed bulbs under a 16-hr photoperiod. Both species also formed bulbs under a 12-hr daylength; *A.* × *wakegi* formed bulbs even in an 8-hr daylength. Temperature of 20 °C more promoted bulbing in both species than at 25 and 30 °C.

Key Words: *Allium* × *wakegi*, bulb formation, daylength, shallot, temperature.

Introduction

Bulb formation in shallot has not been studied well in comparison with that of the common onion (*Allium cepa* L.). Jenkins (1954) showed that long days and relatively high temperatures are necessary for bulb formation in shallots. Bulb formation in *A.* × *wakegi* Araki, an inter-specific hybrid between Welsh onion (*A. fistulosum* L.) and shallot (Tashiro, 1980), is induced by long days as in common onion (Hasegawa et al., 1979; Okubo et al., 1981). Shallot and *A.* × *wakegi* are, however, cultivated in tropical Asian countries where the daylength is always near 12 hrs (short daylength) (Arifin and Okubo, 1996) which indicate that short day shallot and *A.* × *wakegi* exist as do some short day cultivars of common onion.

In this study, effects of daylength on bulb formation in some accessions of shallot collected in Indonesia and *A.* × *wakegi* collected in Indonesia and Japan were examined.

Materials and Methods

Plant materials

Two accessions of shallot ‘Gunung Rajo’ and ‘Batu-3’ and two of *A.* × *wakegi*, ‘Saruran-6’ and ‘Tongging’, both collected in Indonesia and two accessions of *A.* × *wakegi* of Japan, ‘Yatsushiro’ and ‘Ikemi’ were used.

Culture

After collection the bulbs used in this study were propagated in the field at Kyushu University. The bulbs were planted in sand in plastic pots or plastic trays. The plants were fed with nutrient solution containing N :

P₂O₅ : K₂O = 15:8:17 (OK-F-1, Otsuka Chemical Co., Japan).

Measurement of bulb formation

The term “bulbing ratio” is used in this study to describe the degree of bulbing. It is the maximum bulb diameter divided by the minimum pseudostem (neck) diameter. A bulbing ratio greater than 2.0 has frequently been taken as indicative of definite bulbing in common onion (Steer, 1980; Mondal et al., 1986) and so it was adapted for shallot and *A.* × *wakegi* in this study.

Effects of daylength on bulb formation

The bulbs were planted on 24 May 1997 and grown in an open field conditions under 16-, 12- and 8-hr photoperiods. The 8- and 12-hr photoperiods were attained by covering the plants with dark cloths; the 16-hr daylength was achieved by giving supplemental artificial lighting with white inflorescent lamps (2.6 μmol · m⁻² · sec⁻¹). All plants were ventilated by electric fans. Measurements were taken on 9 plants per treatment on 13 August for shallot and on 19 November for *A.* × *wakegi*. A single bulb can produce numerous bulblets during its growth so that number of newly formed bulbs initiated varied depending on the accessions and culture conditions.

Effects of daylength and temperature on bulb formation

The bulbs were planted on 27 May 1997 and grown at 30, 25 and 20 ± 2 °C with relative humidity of 70 ± 5% in the phytotron of the Biotron Institute, Kyushu University. Between 17 June and 16 September, the plants were exposed to 16-, 12- and 8-hr photoperiods. The daylengths were controlled as described above. The intensity of the supplemental artificial lighting was 21.1 μmol · m⁻² · sec⁻¹. Four bulbs were planted for each treatment. Shallots grown at 25 and 30 °C were harvested on 13 August, whereas shallot at 20 °C and *A.* × *wakegi*

Received; July 6, 1998. Accepted; September 8, 1998.

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were collected on 17 September for measurements.

Effects of temperature on bulb formation under 12-hr daylength

The bulbs of five accessions were planted on 30 May 1997; those of 'Batu-3' were planted on 19 July 1997. They were grown in growth cabinets at 25 and 20 °C under artificial lights ($250 \mu\text{mol} \cdot \text{m}^{-2} \cdot \text{sec}^{-1}$) under a 12-hr photoperiod. The four plants per treatment were harvested on 17 September and measured.

Results

Effects of daylength on bulb formation

Bulbing ratios were 3.5 to 6.7; the highest ratio in each accession of shallot and *A. × wakegi* occurred under a 16-hr daylength (Table 1). Under a 12-hr

daylength, the bulbing ratios of shallot 'Gunung Rajo' and *A. × wakegi* 'Yatsushiro' were equal to that under a 16-hr treatment. Other accessions exposed to the 12-hr daylength also had high bulbing ratios. Under an 8-hr photoperiod, the bulbing ratios ranged from 1.0 to 2.0 in all accessions; that of 'Yatsushiro' was highest at 2.0.

Effects of daylength and temperature on bulb formation

The highest bulbing ratios were obtained under 16- and 12-hr photoperiods under most temperature treatments (Table 2). Two shallot accessions did not form bulbs at any temperature under an 8-hr daylength. Two *A. × wakegi* accessions 'Saruran-6' from Indonesia and 'Yatsushiro' from Japan also did not form bulbs under 8-hr daylength at 30 and 25 °C but did so at 20 °C. Other two *A. × wakegi* accessions 'Tongging' from Indonesia and 'Ikemi' from Japan formed bulbs under

Table 1. Effects of daylength on bulbing ratio in shallot and *A. × wakegi* grown under field conditions.

Daylength (hr)	Shallot from Indonesia		<i>A. × wakegi</i> from Indonesia		<i>A. × wakegi</i> from Japan	
	Gunun Rajo	Batu-3	Tongging	Saruran-6	Yatsushiro	Ikemi
16	6.7c	8.2c	4.2c	4.0c	3.9c	3.5c
12	6.2b	6.6b	3.2b	2.4b	3.6b	2.2b
8	1.0a	1.0a	1.3a	1.0a	2.0a	1.0a

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

Table 2. Effects of temperature and daylength on bulbing ratio in shallot and *A. × wakegi*.

Temperature (°C)	Daylength (hr)	Shallot from Indonesia		<i>A. × wakegi</i> from Indonesia		<i>A. × wakegi</i> from Japan	
		Gunun Rajo	Batu-3	Tongging	Saruran-6	Yatsushiro	Ikemi
30	16	4.2b	5.1b	5.0d	4.7e	5.2e	4.7d
	12	5.3c	- ^z	3.6bc	3.0bc	5.5e	2.9ab
	8	1.4a	1.0a	2.5a	1.0a	1.9a	2.8ab
25	16	5.5cd	4.5b	7.1e	3.6cd	4.4d	4.3d
	12	6.1cd	2.3a	4.1c	2.6b	3.6bc	3.8c
	8	1.0a	1.0a	3.2ab	1.0a	1.0a	2.7a
20	16	6.4d	5.1b	7.6e	3.8d	4.1cd	3.7c
	12	5.8cd	6.5c	5.4d	2.6b	3.4b	3.7c
	8	1.6a	1.6a	3.0ab	2.9b	4.1cd	3.2b

^z Not measured.

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

Table 3. Effects of temperature on bulbing ratio in shallot and *A. × wakegi* under 12-hr daylength.

Temperature (°C)	Shallot from Indonesia		<i>A. × wakegi</i> from Indonesia		<i>A. × wakegi</i> from Japan	
	Gunun Rajo	Batu-3	Tongging	Saruran-6	Yatsushiro	Ikemi
25	5.0	5.8	3.8	2.9	3.7	3.0
20	5.5	4.9	5.4	3.4	4.1	3.5
Significance ^z	ns	**	*	*	ns	*

^z ns, * and **, nonsignificant, significant at p=0.05 and significant at p=0.01, respectively by t-test.

8-hr daylength at any temperature although the bulbing ratios were less than under 16- or 12-hr.

Effects of temperature on bulb formation under 12-hr daylength

All the accessions formed bulbs under 12-hr daylength at 20 °C ; four out of six accessions gave significantly higher bulbing ratios than those kept at 25 °C (Table 3).

Discussion

The longer the daylength was, the more bulbs the shallot and *A. × wakegi* formed. Thus, these species are long-day plants for bulb formation. The shallot is more reluctant to form bulbs under 8-hr daylength than *A. × wakegi*.

Hasegawa et al. (1979) and Okubo et al. (1981) considered *A. × wakegi* as a long day plant but they did not mention well the response of the plant to the daylength available in the tropic regions where the daylength is constantly 12 ± 1 hrs throughout the year. We found that some accessions of this species as well as the shallot will initiate bulbs under 12-hr and even under 8-hr photoperiod. Although not all the accessions were surveyed for their response to photoperiod in this study, some or many accessions can form bulbs under short days because many of them are grown in the tropical regions. There may be differences in the photoperiodic response by accessions.

Photoperiodic response of shallot and *A. × wakegi* was similar to that of short day cultivars of common onion which are adapted to the tropics. Uzo and Currah (1990) stated that short day onion should not be regarded as true short day plants. Rather they are physiologically long day plants which have a relatively short daylength requirement to induce bulbing. Bulbing still requires a certain minimum or critical photoperiod (11–13 hrs of light), and the process is faster in photoperiods longer than this minimum.

Bulbing is promoted more at lower temperature in

both the shallot and *A. × wakegi*, particularly under an 8-hr photoperiod. In the common onion the higher the temperature, the shorter a minimum photoperiod is needed to induce bulb formation (Steer, 1980; Terabun, 1981).

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シャロット (*Allium cepa* L. var. *ascalonicum* Backer) およびワケギ (*A. × wakegi* Araki) の日長および温度に対する球根形成反応

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摘 要

シャロットおよびワケギの日長および温度に対する球根形成反応を調査した。供試したインドネシア産のシャロット2系統およびワケギ2系統ならびに日本産のワケギ2系統はいずれも16時間日長下で球根を形成した。両種は12時間日長下でも球根を形成し、ワケギは8時間日長下においても球根

を形成した。球根形成は両種とも20 °C ~ 30 °C の範囲内では温度が低いほど促進された。

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