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Dormancy in Shallot (*Allium cepa* var. *ascalonicum*) and *Allium*×*wakegi* Bulbs and Its Breaking by Scale Cutting

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Dormancy status in the bulbs of 12 shallot and 66 *A.*×*wakegi* accessions was investigated and a more time saving and practical method for dormancy breaking of the bulbs was studied. Dormancy of shallot is weaker than that of *A.*×*wakegi*. The average days to 50% sprouting of *A.*×*wakegi* accessions were not significant among Indonesian, Japanese and other countries' accessions, but the variation of them was more marked in Japanese than in Indonesian accessions. The bulbs of which the upper half or one third had been transversely cut just before planting sprouted earlier than intact control bulbs. The closer the cut was made to the growing point, the earlier was the sprouting. Those of which the half portion had been longitudinally cut also sprouted earlier than the intact control. This old and simple technique, to cut transversely upper one third or half of the bulbs, was suggested to be practically used in shallot and *A.*×*wakegi* production. Those of which the upper half had been transversely cut and the cut surface had been covered with plain lanolin also sprouted earlier than the intact control, suggesting that the removal of some inhibiting substances contained in the scales promoted sprouting.

INTRODUCTION

Sprouting is a problem in onion storage, but early sprouting cultivars which enable two times of planting in a year and can avoid from the risk of edaphic factors such as drought and heavy rain are sometimes very important in tropical countries.

Shallot (*Allium cepa* var. *ascalonicum*) is a small–bulb onion and widely cultivated in southeast Asian countries. Another small–bulb onion is *Allium*×*wakegi*, which is an F_1 hybrid of Welsh onion (*Allium fistulosum*)×shallot (Tashiro, 1980). It is also grown there as well as in Western Japan (Fujieda *et al.*, 1980; Inden and Asahira, 1990) although it is not major in the tropics. There is a wide variation in the period of dormancy, unsprouting period after bulb harvest, in *A.*×*wakegi* accessions (Fujieda *et al.*, 1980), whereas little known is the dormancy in shallot. Kawasaki (1984) reported that the dormancy in two shallot accessions introduced from Thailand and Indonesia was very weak under Japanese climate conditions.

The dormancy in *A.*×*wakegi* is released by high temperature (Fujieda *et al.*, 1980; Hasegawa *et al.*, 1981). It is also released by forced water infiltration or by removal of foliage scales (Hasegawa *et al.*, 1991), and the forced water infiltration method is now recommended and used in some areas of Japan since it is less time consuming than high temperature treatment.

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We have collected many accessions of shallot and *A.*×*wakegi* from Asian countries. The dormancy status of them was surveyed for providing information for selecting early sprouting accessions for breeding purpose and an easier, more time saving and practical method than the forced water infiltration method or other conventional methods for dormancy breaking was investigated in this study.

MATERIALS AND METHODS

Survey of dormancy status in shallot and *A.*×*wakegi*

Twelve shallot accessions collected in Indonesia and 66 *A.*×*wakegi* accessions collected in Indonesia (20 accessions), Japan (30), China (6), Korea (5), Taiwan (2), Philippines (1), Myanmar (1) and Mexico (1) were used. Since the two species are very similar to each other in their morphology and physiology, all the collected accessions were identified by isozyme analysis (Arifin and Okubo, 1996) before experiments. All the accessions were propagated for years in the field of Kyushu University after collection. After harvesting, the bulbs were planted in sand in plastic pots on 16–17 April 1997 and grown in a plastic greenhouse until their leaves stopped growing and withered. The plants were fed with nutrient solution containing $N:P_2O_5:K_2O$=15:8:17 (OK–F–1, Otsuka Chemical Co., Japan) with watering. Nine bulbs for each accession were used. The time of sprouting and the time of maturity were judged when more than half of the planted bulbs sprouted and withered, respectively.

Effects of scale cutting on sprouting of shallot and *A.*×*wakegi*

Two Japanese *A.*×*wakegi*, 'Hakata' and 'Murasakidane', two shallots, 'Dien' from Indonesia and 'Taherpur' from Bangladesh were used. After harvesting, the bulbs received the following treatments; (1) upper one third of the bulbs were transversely cut, (2) upper half of the bulbs were transversely cut, (3) upper half of the bulbs were transversely cut as (2), but the cut surface was covered with plain lanolin paste just after cutting, (4) half of the bulbs were longitudinally cut avoiding from injuring growing points, and (5) no surgical treatment was given as a control (intact bulbs). They were then planted on 8–9 May 1997 and grown in the plastic greenhouse in the same manner as described above. Sprouting was judged when the leaves reached 1 cm long. Nine bulbs for each accession were used.

RESULTS AND DISCUSSION

Survey of dormancy status in shallot and *A.*×*wakegi*

Shallot took 6.6 days after planting to obtain 50% sprouting, and it was 12 days earlier than *A.*×*wakegi* did (18.7 days in average) (Table 1). The earliest sprouting in shallot accession was 'Losari' that took only two days after planting and the latest was 'Batu–2' that required 14 days. There were no significant differences in the days to 50% sprouting among the *A.* ×*wakegi* accessions from Indonesia, Japan and other countries. Variation of days to 50% sprouting in *A.*×*wakegi* was more marked within Japanese accessions as already reported by Fujieda *et al.* (1980) than within Indonesian accessions. Japanese accessions 'Miyazaki–1', 'Taketomi' and 'Yatsushiro' as well as Chinese accessions

Table 1. Days to sprouting and leaf withering from planting in shallot and *A.* × *wakegi*.

Accession	Days to	
	Sprouting	Leaf withering
Shallot		
Batu–2	14	90
Batur	4	70
Colo	9	75
Karantengah	5	70
Kayutanduk	9	75
Kedak	4	70
Losari	2	70
Medan Merah	4	70
Pandak	3	70
Probolinggo	5	70
Tasik	8	70
Wonorejo	12	75
Average	6.6±1.09[z]	72.9±0.68
A. × *wakegi* collected in Indonesia		
Alam Indah	16	85
Bandung	16	85
Bawang Merah	14	80
Cikareo–2	15	80
Ciledog–2	18	85
Ciledog–4	21	85
Ciledog–5	19	85
Ciledog–6	17	85
Girimulyo–3	15	85
Indonesia	18	85
Mojo	17	80
Panundaan	18	85
Saruran–6	16	90
Saruran–7	27	90
Sibolangit	17	85
Sinawungan	17	85
Tongging–1	24	85
Tonsewer–2	17	85
Wataes–3	17	90
Wonokrio	18	85
Sub average[y]	17.9±0.69	85.0±0.63
A. × *wakegi* collected in Japan		
Bise	20	90
Daisen	20	90
Genkai	17	90
Ginoza	19	85
Haebaru	17	80
Iimori	17	90
Ikemi	16	85
Inazawa	21	95
Ishigaki	17	80
Karatsu	16	90
Kihara	13	80
Kihara–wase	16	85
Kunisaki	14	90
Mihara	16	90
Miyazaki–1	31	95
Miyazaki	17	90
Murasakidane	14	85
Naha–2	18	90
Sera	13	80
Shimonoseki	17	90
Shirodane	13	90
Shodon	19	90
Taketomi	42	95
Teruma	14	85
Toubaru	16	85
Uehara	18	85
Yakena	15	85
Yatsushiro	31	95
Yonabaru	14	80
Yonakuni	18	85
Sub average	18.3±1.13	87.5±0.86
A. × *wakegi* collected in other countries		
Burma	16	85
Chegidong	21	90
China–2	23	90
China–3	17	80
China–4	41	95
China–5	26	95
China–6	20	80
Korea–1	20	95
Korea–2	9	85
Korea–3	14	90
Korea–4	15	85
Phillipine–1	16	90
Shaden	35	95
Taiwan-koba	16	80
Taiwan–2	23	85
Viscaino	13	80
Sub average	20.3±2.05	87.5±1.44
Grand average[y]	18.7±0.74	86.7±0.57

[z] Mean ± standard error.
[y] Sub average; Average in each area, Grand average; Average in all *A.* × *wakegi* accessions.

'China–4' and 'Shaden' took more than 30 days for 50% sprouting, but there was no accessions from Indonesia that took more than 30 days. Northern accessions of *A.*× *wakegi* are tend to be later in sprouting than southern accessions in general. In *A.*× *wakegi* the latest sprouting accession was 'Taketomi' that took 42 days while the earliest sprouting accession was 'Korea–2' that took only nine days. Changes in % sprouting until full sprouting (Fig. 1) also indicate that the dormancy of shallot is weaker than that of *A.*×*wakegi*.

Shallot is also earlier to mature than *A.*×*wakegi*. The average growth duration of shallot was 72.9 days, whereas that of *A.*×*wakegi* was 86.7 days. This trait in shallot is also advantageous in twice–a–year cultivation in the tropics. Within *A.*×*wakegi* accessions, those from Indonesia matured only two days earlier than those from Japan and other countries.

There is neither bulb formation nor endo–dormant period in *A. fistulosum*. It can continue growing in adequate environmental conditions. *A.*×*wakegi* is an F_1 hybrid of *A. fistulosum*×shallot and the dormancy of *A.*×*wakegi* is stronger than that of shallot. Stronger dormancy in the F_1 (*A.*×*wakegi*) has been derived from the combination of no dormancy in *A. fistulosum* and weaker dormancy in shallot.

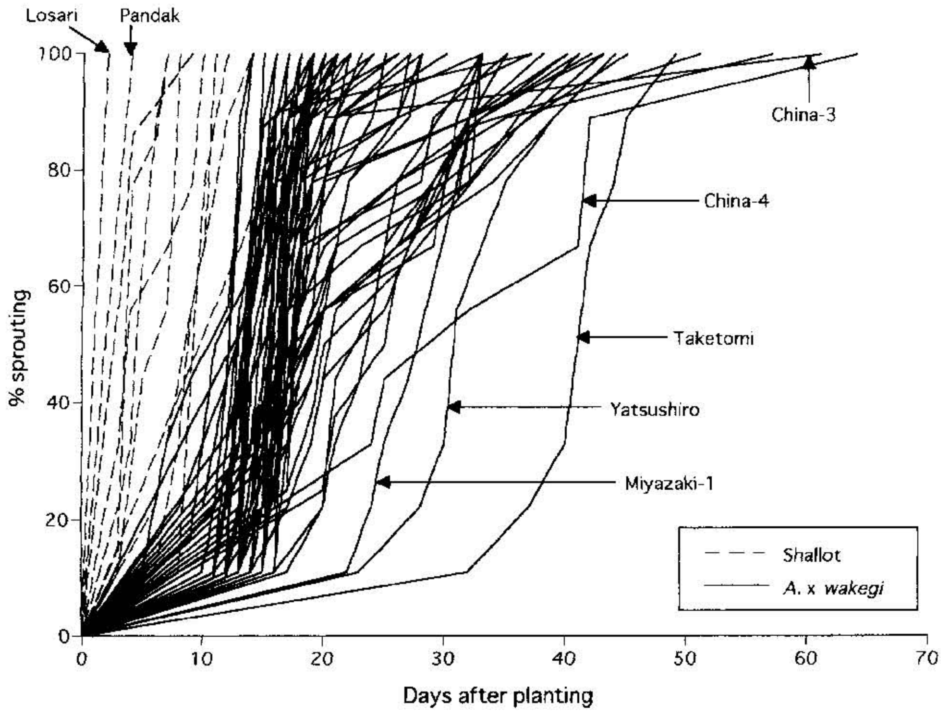

Fig. 1. Changes in % sprouting in the accessions of shallot and *A.*×*wakegi*. Some earliest and latest sprouting accessions are indicated by their accession names.

Effects of scale cutting on sprouting of shallot and *A.×wakegi*

The bulbs received surgical treatments of any kind sprouted earlier than intact bulbs in all the accessions of shallot and *A.×wakegi* examined even though there was a great variation of the changes in sprouting in control plants (Fig. 2). *A.×wakegi* 'Hakata' in intact control sprouted earlier than the intact control of two shallot accessions, and the cutting treatment also showed the promoting effect for sprouting. The bulbs of which the upper half had been cut sprouted earlier than those of which upper one third had been cut. Those of which the half portion had been longitudinally cut also sprouted earlier than the intact control. The closer the cut is made to the growing point, the faster is the sprouting.

Jones (1920) observed that sprouting of onion (*Allium cepa*) bulbs was promoted by cutting the bulbs. Boswell (1923) studied further the effect of cutting and found that the closer the cut to the sprout initials, the earlier was the sprouting. The results obtained from shallot and *A.×wakegi* in the present study are similar to those in onion. Longitudinal cutting in onion, however, showed less promoting effect than transverse cutting (Jones, 1920; Boswell. 1923), whereas the effects were similar in both treatments in the present study. Since true onion is usually propagated by seeds, the technique to promote sprouting has not been applied to practical onion cultivation at all. Shallot and *A.×wakegi* are generally propagated asexually by multiplied bulb division, so that the old and simple technique, cutting upper part of bulbs transversely, may be practically used for breaking dormancy. Longitudinal cutting may cause the damage of the sprout initials. Neither growth retardation nor decrease in growth vigor in the treated bulbs were observed after planting. The treatment, therefore, seems more time saving and economical than outer scale removing or than the forced water infiltration method developed by Hasegawa *et al.* (1991).

Those of which the upper half had been transversely cut and the cut surface had been covered with plain lanolin also sprouted earlier than the control (intact bulbs) and there was no significant difference in sprouting from those of which the upper half had been transversely cut but not covered with lanolin. Boswell (1923) conjectured that air flow more easily reached the sprout initials through the spaces between scales with transversely cut bulbs in onion. He demonstrated that oxygen, not the stimulus of cutting, promoted sprouting, because covering the cut surface with paraffin nullified the effect. His results is, however, opposite to those in this study.

Kato (1966) found that the removal of outer scales led to earlier sprouting in onion and Hasegawa *et al.* (1991) did the same in *A.×wakegi*. Lin and Roberts (1970) showed that in Easter lily (*Lilium longiflorum*) removal of daughter scales accelerated sprouting. These treatments do not seem to make air flow easily reach the sprout initials. Rather it may well be considered the reason for early sprouting by removing some portion of scales is simply the removal of some inhibiting substances for sprouting being contained in the removed scale portion as suggested by Lin and Roberts (1970) and Wang and Roberts (1970) in Easter lily. The substance inhibiting sprouting in the bulbs of *A.× wakegi* has been proved to be abscisic acid (Yamazaki *et al.*, 1995).

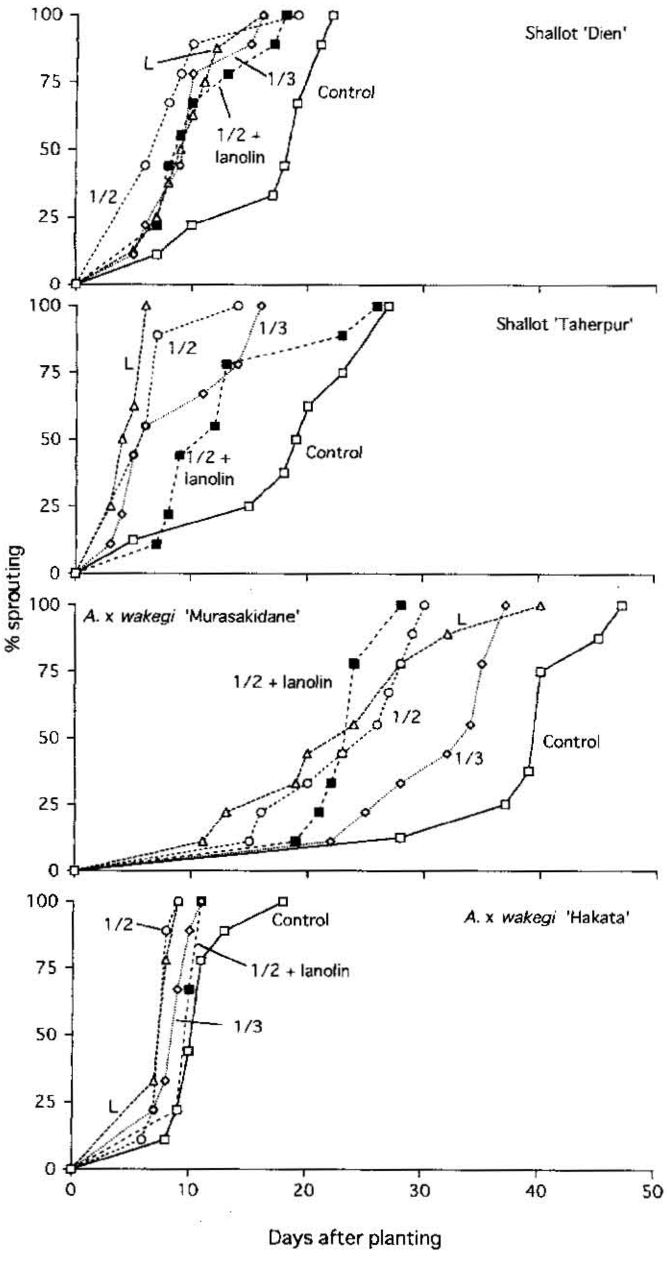

Fig. 2. Effects of bulb cutting on sprouting of shallot and *A.*×*wakegi*. Control; Intact control, 1/3; Upper one third of bulbs was transversely cut, 1/2; Upper half of bulbs was transversely cut, 1/2+lanolin; Upper half of bulbs was cut and the cut surface was covered with plain lanolin, L; Bulbs were cut longitudinally remaining growing point uninjured.

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