

# USE OF PHOTOPERIOD IN IDENTIFYING SUITABLE CULTIVARS OF BIG ONION (*Allium cepa* L.) FOR THE DRY ZONE OF SRI LANKA

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## ABSTRACT

Bulbing in big onion is primarily controlled by the photoperiod and is promoted by long-day conditions. Cultivars differ in their sensitivity to increasing photoperiods and cultivation of onion in tropical regions is dependent on identifying accessions capable of bulbing under the relatively short prevailing daylengths. The bulbing behaviour of 20 cultivars of tropical big onion was studied under 12 h and 16 h photoperiods at the Field Crops Research and Development Institute at Maha Illuppallama to develop a rapid screening technique for identifying cultivars capable of bulbing under local conditions. Using 60 W tungsten lights for 4 h from 6.00 pm simulated the 16 h photoperiod. A high correlation was observed in bulbing behaviour under 16 h and 12 h photoperiods. The bulbing trend of the tested cultivars remained the same under both photoperiods and the time taken for bulbing was reduced by 60% in the 16 h photoperiod. A significant correlation was also observed between the time taken to bulb under the 16 h photoperiod and the time taken to maturity under the 12 h photoperiod. Hence, it is also possible to use a long day environment for early prediction of time to maturity of any big onion cultivar under local conditions.

**KEY WORDS:** Cultivar evaluation, Photoperiod extension, Short-day onion, Tungsten light.

## INTRODUCTION

Day length is the principal environmental factor which initiates bulbing in onion (*Allium cepa* L.). Usually, cultivars are selected based on their ability to produce bulbs under the daylength prevailing in the region where they are to be grown. The photoperiod in Sri Lanka is marginal for big onion bulbing. Therefore, use of cultivars that are capable of bulbing under relatively short daylengths is important for obtaining a high yield of good quality bulbs. Seed stocks of different cultivars available in the market vary from season to season. Therefore, screening of these seeds should be done before the growing season begins in each year in order to identify suitable cultivars. Thus a rapid and simple screening technique needs to be developed to solve this problem.

Previous workers have shown that tropical onion cultivars bulb earlier under long-day conditions (Magruder and Allard, 1937; Kato, 1964; Butt, 1968; Terabun, 1971; Steer, 1980 and Wiles, 1989). Based on four cultivars, Austin (1972) concluded that, though bulbing occurred earlier under longer days, the sequence in which they bulbed remained constant. However, Wiles (1989) reported that some cultivars behaved differently in terms of their bulbing sequence under field conditions compared to controlled environmental conditions. The investigations described in this paper were carried out on a wide range of cultivars which includes short, medium, and long day types, to determine if daylength extension could be used as a basis for screening onion cultivars for use in the low country dry zone of Sri Lanka.

## MATERIALS AND METHODS

This experiment was carried out at the Field Crops Research and Development Institute at Maha Illuppallama from January to September in 1995.

Twenty big onion cultivars from early to late maturing groups were used during this study. Details of the cultivars tested and their source are given in Table 1. Two experiments were conducted to test their bulbing behaviour under 12 h and 16 h photoperiods.

In the two experiments cultivars were arranged in a randomised complete block design with four replications. Although testing under the two photoperiods were done separately, the conditions provided for the experiments were identical for the comparison of data obtained under the two photoperiods.

Seeds of the different cultivars were sown in a field nursery in March 1995. After 5 weeks, seedlings were transplanted on raised beds of 100 x 90 x 15 cm at a spacing of 10 cm x 10 cm for the 12 h experiment. Another set of seeds of the same cultivars were sown on the same date for the 16 h photoperiod experiment. The 16 h photoperiod was provided only after 2 weeks from sowing using a row of 60 W tungsten lamps held 1 m above the nursery beds. The lamps within the row were fixed 1 m apart. Illumination was given for 4 h from 6 p.m. All the cultural practices adopted were the recommendations for big onion by the Department of Agriculture in Sri Lanka (Anon, 1990). Natural photoperiod during the field experiment varied between 12.00 h and 12.20 h. photosynthetically active radiation (PAR) levels at midday were between 1200-2000  $\mu\text{mol}/\text{m}^2/\text{s}$  during the period of study. Air temperature varied from 28 - 33°C during day and 23-28°C at night.

Non-destructive and destructive methods were used in order to study the effect of photoperiods on growth and bulbing. A non-destructive measure, days to attain a bulbing ratio (BR) of 2 (maximum bulb diameter/minimum neck diameter) (Clark and Heath, 1962) and a destructive measure, days to bulb scale initiation (SI) were monitored by taking measurements at weekly intervals from 3 weeks after planting and 3 weeks after sowing in 12 h and 16 h experiments respectively. Three randomly selected seedlings were used in taking these measurements. Plants were dissected through the base to determine the date of scale initiation (Heath and Holdsworth, 1948). The date at which 50% of the remaining plants reached the leaf fallover stage was recorded as the date of maturity or neck fall (NF).

## RESULTS AND DISCUSSION

Days to attain different growth and bulbing stages under 12 h and 16 h photoperiod conditions are presented in Table 2. It reveals that the order of attaining different growth and bulbing stages under 16 h photoperiod is generally similar to that under 12 h photoperiod (Table 2). Days to neck fall under the 12 h photoperiod in the field experiment varied from 83 to 192 indicating that the varieties used in the experiment were representative of a wide range (short, medium, and long day types) of maturity groups. Days to reach a bulbing ratio of two, days to scale initiation and days to neck fall under the 16 h photoperiod were 40 - 60 % lower when compared with that of the 12 h photoperiod (Table 2). The results confirm the findings of previous workers based on a smaller number of cultivars (Magruder and Allard, 1937; Austin, 1972; Wiles, 1989).

**Table 1. Cultivars used in the study and their sources.**

Cultivar	Maturity Group	Source
Agrifound Light Red	Early	Ass. Agric.Dev. Foundation, India
Agrifound Rose	Early	Ass. Agric.Dev. Foundation, India
Agrifound Dark Red	Early	Ass. Agric.Dev. Foundation, India
Australian Brown	Medium	Straathof, RSA
Early Lockyer Brown	Early	Yates, Australia
Extra Early Cream Gold	Early	New world seeds, Australia
Galil	Early	Hazera, Israel
H-222	Early	Hazera, Israel
H-489	Early	Hazera, Israel
Hyfast F1	Late	Elsom seeds, UK
Hyton F1	Late	Elsom seeds, UK
Hysam F1	Late	Elsom seeds, UK
Pusa Red	Early	Royal Sluis, Holland
Red Creole – C5	Early	Sunseed, USA
Superex	Early	Takii, Japan
H-226	Early	Hazera, Israel
Imai Early Yellow	Early	Takii seeds, Japan
Ben Sheman	Early	Hazera, Israel
Candy	Medium	Petoseed, USA
Utopia	Medium	Asgrow, USA

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**Table 2. Days to attain different growth/bulbing stages under 12 h and 16 h photoperiod, arranged in an ascending order on the basis of the data in column 2 of the table (BR2/12 h).**

Variety	BR2		SI		NF	
	12h	16h	12h	16h	12h	16h
Early Lockyer Brown	64	31	66	27	83	51
Superex	66	32	71	32	92	59
Agrifound Rose	72	31	71	29	97	59
Galil	74	35	76	33	110	59
H-489	76	36	76	33	122	66
Agrifound Light Red	76	36	81	35	122	62
Red Creole-C5	77	40	85	36	123	60
H-226	79	43	85	39	119	60
H-222	87	48	105	50	145	74
Agrifound Dark Red	87	47	105	42	135	64
Pusa Red	88	46	71	46	123	66
Ben Sherman	88	46	104	46	149	71
Extra Early Cream Gold	89	48	104	44	157	65
Imai Early Yellow	90	51	93	40	164	64
Candy	91	67	110	50	149	76
Utopia	95	66	104	54	152	72
Australian Brown	101	69	118	50	161	83
Hyton F1	115	80	135	81	182	110
Hyfast F1	115	81	135	79	187	110
Hysam F1	115	81	135	79	192	110
SED (df=57)	6.1	4.0	6.2	3.0	8.1	3.0

**Legend: BR2 - Bulbing ratio of 2, SI - Initiation of bulb scale, NF - Neck fall,**

The physiological basis of onion bulbing could be used in explaining these results. Throughout the growth of the onion plant it accumulates a stimulus named bulbing stimulus. The minimum photoperiod of 12 h is required to induce the synthesis of bulbing stimulus. The rate of synthesis of this stimulus mainly depends on the length of the photoperiod and the rate of synthesis increases with the increase of photoperiod (Brewster, 1990). The concentration of bulbing stimulus that is needed to induce bulbing (initiation of scale leaves) varies between cultivars and is a constant for each variety (Mettananda, 1997). Onion plants continue to produce leaves with a leaf blade until this critical concentration of stimulus is accumulated and thereafter, switch over to produce scale leaves with no leaf blades. Time to this switch over becomes shorter with increase of photoperiod (Brewster, 1994). This could be the reason for the earlier switch over from bladed leaves to bulb scale production under the 16 h photoperiod. Earliness under the 16 h photoperiod varied depending on the photoperiodic sensitivity and the maturity group of the cultivar but followed a similar order in attaining different growth and bulbing stages to that under the 12 h photoperiod. Significant correlations observed between similar growth and bulbing parameters under 12 h and 16 h photoperiod (Table 3) also support the above observation. Among the different measurements used to determine the onset of bulbing it was observed that time to attain a bulbing ratio of 2 was close to that of scale initiation. Under the 12 h photoperiod, scale initiation occurred a few days later than the time at which a bulbing ratio of 2 was reached. However, under a 16 h photoperiod bulb initiation occurred a few days earlier probably as a consequence of a more rapid switch over to scale initiation under longer photoperiods (Table 2).

Different growth and bulbing stages (BR2 and SI) under the 16 h photoperiod showed a significant correlation with the time to maturity (neck fall) under the 12 h natural photoperiod (Figs. 1 and 2). These observed correlations confirm the previously discussed relationship between the growth and bulbing behaviour of different big onion cultivars under the 12 h and 16 h photoperiods. Nevertheless this relationship could be used for an early prediction of time to maturity of a given cultivar under the 12 h natural photoperiod.

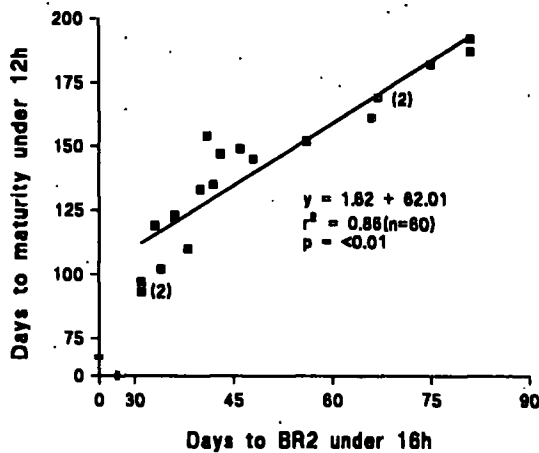
### CONCLUSIONS

Screening of onion cultivars for bulbing behavior under a long photoperiod reduced the time taken for assessment up to 60% over conventional methods. Therefore, this method could be used as a rapid preliminary screening technique for identifying cultivars for use in the tropics where conditions for bulbing are often marginal. In a situation like Sri Lanka where seed stocks of different cultivars in the market vary from season to season, this screening technique could be used for testing the suitability of seed lots before purchasing in large quantities. Possibility of use for an early prediction of the cropping duration under natural field condition is another advantage of this method. This method could also be used in preliminary assessments of cultivars for any specific photoperiod condition. The possibility of using it for rapid screening of large quantities of onion germplasm at the nursery stage is an additional advantage that could lead to saving of time and money compared with extensive field trialling.

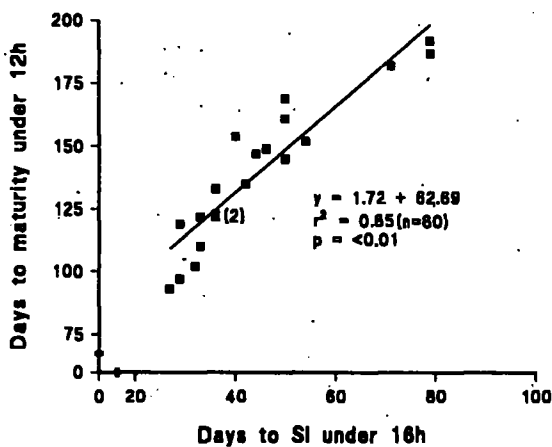
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**Table 3.** Relationship between days to reach different growth and bulbing parameters under 12 h (Y) and 16 h (X) photoperiods.

Parameter	Regression	r <sup>2</sup>	n	p
Bulbing Ratio of 2.0 (BR)	Y = 0.84x + 47	0.83	20	0.01
Scale initiation	Y = 1.43x + 48.6	0.86	20	0.01
Maturity (50% neck fall)	Y = 1.40x + 37.9	0.84	20	0.05



**Fig. 1.** Relationship between days to attain a bulbing ratio (BR) of 2 under an extended 16 h photoperiod and time to maturity (neck fall) under natural 12 h photoperiod.



**Fig. 2.** Relationship between days to scale initiation (SI) under an extended 16 h photoperiod and time to maturity (neck fall) under natural 12 h photoperiod.

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