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RESPONSE OF ONION (*Allium cepa* L.) BULB YIELD TO DAY LENGTH EXTENSION

S. HABILA AND O. A. T. NAMO

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ABSTRACT

An experiment was carried out between October 2007 and March 2008 at the permanent site of the University of Jos (08°53'E, 09°57'N; 1,159 m above mean sea level) to investigate the effect of day length extension on the yield of onion bulb (*Allium cepa* L.). Two varieties of onion ('Violet de Galmi' and 'Red Creole') were combined with normal, additional 2, 4 and 6 hours after darkness in a completely randomized design with four replications. The results showed that the mean weight of bulb, size of bulb, diameter of bulb, length of bulb and the mean number of rings per bulb increased with increasing day length extension, ranging from 119.74 g to 223.23 g; 15.39 cm - 25.04 cm; 5.69 cm - 8.60 cm; 4.31 cm - 5.76 cm and 6.13 - 10.25 rings respectively. The variety "Violet de Galmi" exceeded the variety "Red Creole" in all parameters except the mean bulb length, where it was 4.97 cm as against 5.03 cm in the variety "Red Creole". There was significant day length extension and variety interaction on the mean bulb-weight, bulb-size, bulb-diameter, bulb-length and the number of rings per bulb. The variety "Red Creole" was observed to be more affected by longer day length extension than the variety "Violet de Galmi" in the Jos-Plateau environment. The overall results indicate, however, that the variety "Violet de Galmi" might be more suited to the Jos-Plateau environment than the variety "Red Creole" in terms of the yield of onion bulb.

KEYWORDS: Day length extension, *Allium cepa* L., Bulb yield

INTRODUCTION

Onion (*Allium cepa* L.) belongs is of the family Alliaceae. The crop is most extensively grown on light soils, which may be sandy-loam or silt-loam with a pH range of 5.8 to 6.5 (Kochhar, 1986), and in some cases it thrives in a pH of 6.0 to 6.8 in some soils (Costa, 1995). The plant is grown primarily for its bulbs and leaves which could be eaten raw (as in salads), either cooked or fried in a large spectrum of different dishes, where it produces a flavour or pungency.

Bulbing is initiated by a combination of day-length (photoperiod) and temperature; critical day length required for bulbing may be shorter at higher temperatures (Austin, 1972). Day length and temperature influence bulb formation in onions. Before bulbing occurs, a certain amount of vegetative growth is required before the plant can respond to day length. At a specific threshold, past the “juvenile” stage of leaf growth, the plant becomes sensitive to the bulbing stimulus that is triggered if the days are long enough (Ibrahim, 2010). When day length is at or greater than the threshold for bulb initiation of a particular cultivar of onion, bulbing occurs only if the average daily temperature is 60 °F (16°C) or above, and the average night temperature is 60–80°F (16–28°C) (Ibrahim, 2010). If the requirement for day length is not met (that is, the days are not long enough when the onion plant is physiologically mature), leaf production continues without bulb formation (Ibrahim, 2010). Bulbing response is reported to be stronger when night-time temperatures are low and the plants are large (Ibrahim, 2010).

Generally, onion development, bulb formation and maturity are a function of the interaction of the environment with genotype (Brewster, 1990). In most onion-producing regions of the world, bulb-formation occurs under conditions of increasing photoperiod (day-length extension), and the minimal requirements are between 12 and 16 hours of increasing light (Brewster, 1990; Ibrahim, 2010). The response of onions to photoperiod, however, depends on the cultivar (Costa, 1995; Ibrahim, 2010).

In Nigeria, onion is reported to rank among the top five per cent of the most important vegetables (NIHORT, 1986). It is commonly grown in States like Borno, Kaduna, Kano and Sokoto (Hassan, 1987). Due to the significance of onion bulbs in Nigeria, research efforts at the National Horticultural Research Institute (NIHORT) have been aimed at the large-scale production of bulbs with high quality (NIHORT, 1986; Hassan, 1987). Despite the use of fertilizers (inorganic or organic), the cultivation of onion is restricted to countries lying in its zones of adaptation. With sound cultural practices such as weed and disease control, soil fertilization and day length extension, it is believed that the yield of onion bulb could be enhanced with good management. The present study was, therefore, aimed

S. Habila, Department of Plant Science and Technology, University of Jos, Plateau State, Nigeria
O. A. T. Namo, Department of Plant Science and Technology, University of Jos, Plateau State, Nigeria

at determining the effect of varying photoperiods (day length extension) on the yield of bulb of two varieties of onion, namely "Violet de Galmi" and "Red Creole".

MATERIALS AND METHODS

Raising of Nurseries

The seedlings where raised in nurseries of flat land. This was prepared by breaking the soil loose to allow air and water to penetrate, and to allow roots of seedlings penetrate. Debris were removed from the flat bed and the soil was levelled.

Transplanting of Seedlings

At eight weeks, the onion seedlings obtained from the seed-beds were transplanted into pots. Before transplanting, each pot was filled with a mixture of sandy soil and organic manure (cow-dung) in a ratio of 3:2 (Adebooye, 1996). The plants were watered (using a watering can) daily in the evening for one week to ensure that they were properly established. The experiment was carried out at the Permanent Site of the University of Jos (08°53'E, 09°57'N; 1,159 m above mean sea level) between October 2007 and March 2008.

The treatment combinations comprised two varieties of onion ("Violet de Galmi" and "Red Creole") and normal, additional 2, 4 and 6 hours after darkness. The experiment was laid out in a completely randomized design with four replications.

The photoperiod treatment included normal day length (control) as well as two, four and six hours of day length extension, which were achieved by exposing the plants to a source of light (two mercury solar light fluorescence bulbs of 150 watts mounted on a pole of about 4 metres). Plants subjected to these treatments were kept under light between 6:00 pm and 12:00 mid-night. The plants treated as control (normal day length) were covered by 6:00 pm and uncovered by 6:00 am the next day together with the other treatments (2, 4 and 6 hour's day length extension). The plants were watered every other day. Weeding was done fortnightly by hand.

The bulbs were harvested at sixteen (16) weeks after transplanting. The onion bulbs were cured (sun-dried) for four days, after which the following parameters were measured.

Table 1: Main effects of Day Length Extension and Variety on Bulb Weight (BW), Bulb-Size (BS), Bulb Diameter (BD), Bulb-Length (BL) and Number of Rings per Bulb (NR) during the 2007 and 2008 Planting Seasons

Light Period (Hours)	BW (g)	BS (cm)	BD (cm)	BL (cm)	NR
0	119.74	15.39	5.69	4.31	6.13
2	179.83	18.63	7.34	4.92	8.50
4	167.18	19.04	7.21	5.01	8.13
6	223.23	25.04	8.69	5.76	10.25
$LSD_{0.05}$	10.69	0.60	0.24	0.22	0.65
Variety					
Violet de Galmi	183.63	20.75	7.86	4.97	8.50
Red Creole	161.36	18.30	6.60	5.03	8.00
$LSD_{0.05}$	7.56	0.06	0.17	0.15	0.46
CV%	5.96	2.95	3.21	4.20	7.60

Key: BW= Bulb-Weight; BS= Bulb-Size; BD= Bulb Diameter; BL= Bulb-Length and NR= Number of Rings per bulb.

Bulb Weight Per Plant: The weights of the three bulbs sampled from each pot were obtained by weighing on a Mettler Balance Model PN 163. The bulbs were weighed in grammes after drying (curing) them (Ibrahim, 2010).

Bulb-Size: The size of each of the three bulbs sampled from each pot was measured in centimetres, using a measuring tape.

Bulb Diameter: The transverse section (diameter) of each of the three bulbs sampled from each pot was measured in centimetres using a measuring tape (Ibrahim, 2010).

Bulb-Length: The length of each of the three bulbs sampled from each pot was measured in centimetres using a measuring tape (Ibrahim, 2010).

Mean Number of Rings Per Bulb: The number of rings in each of the three bulbs sampled from each pot was counted and recorded as the number of rings per bulb.

Data Analysis

Data collected were subjected to a two-way analysis of variance (ANOVA) and the means were compared using the least significant difference (L.S.D) (Steel and Torrie, 1960).

RESULTS

Bulb Weight Per Plant: The mean bulb weight increased with increasing day length extension and the difference between the day length hours was significant ($P<0.05$). The variety "Violet de Galmi" recorded a higher mean bulb weight of 183.63 g which was significantly ($P<0.05$) higher than that of the variety "Red Creole" which is 161.36 g throughout the period of the study except for the 6-hour day-length extension, where the difference in mean bulb weight between the two varieties was not significant ($P<0.05$) (Table 2).

Table 2: Effects of Variety and Increase in Day-Length (Light Period) 0n Mean Bulb Weight (g) of the Onion Varieties during the 2007 and 2008 Planting Seasons

	Light period (Hours)				
Variety	**0**	**2**	**4**	**6 (hr)**	**Mean**
Violet de Galmi	522.11	795.30	775.21	845.45	183.63
Red Creole	435.80	643.30	562.21	940.41	161.36
Mean	119.74	179.18	167.18	223.23	
		$LSD_{0.05}$	Variety (V)	= 7.56	
		Increase in light period (P)		= 10.69	
		P X V		= 15.12	

Mean Bulb-Size: The mean bulb-size ranged from 15.39 cm in the control (normal day-length) to 25.04 cm at 6 hour day-length extension and the difference was significant (P<0.05) (Table 1). The bulb-size in the variety "Violet de Galmi" 20.75 cm, was significantly (P<0.05) higher than that of the variety "Red Creole" 18.30 cm, during the study period except at 6 hour day-length extension, where the difference in mean bulb-size between the two varieties was not significant (P<0.05) (Table 3).

Table 3: Effects of Variety and Increase in Day-Length (Light Period) 0n Mean Bulb Size (cm) of the Onion Varieties during the 2007 and 2008 Planting Seasons

	Light period (hours)				
Verity	**0**	**2**	**4**	**6 (hr)**	**Mean**
Violet de Galmi	63.81	82.10	88.14	97.88	20.75
Red Creole	59.31	66.90	64.15	102.40	18.30
Mean	15.39	18.63	19.04	25.04	
		$LSD_{0.05}$	Variety (V)	= 0.06	
		Increase in light period (P)		= 0.60	
		P X V		= 0.24	

Mean Bulb Diameter: This ranged from 5.69 cm in the control to 8.69 cm at 6 hour light extension and the difference was significant (P<0.05) (Table 1). The variety "Violet de Galmi" recorded a significantly (P<0.05) higher bulb-diameter (7.86 cm) than that of the variety "Red Creole" (6.60 cm) at all but 6-hour period of light extension (Table 4).

Table 4: Effects of Variety and Increase in Day-Length (Light Period) 0n Mean Bulb Diameter (cm) of the Onion Varieties during the 2007 and 2008 Planting Seasons

	Increase in light period				
Verity	**0**	**2**	**4**	**6 (hr)**	**Mean**
Violet de Galmi	23.91	33.75	33.92	34.24	7.86
Red Creole	21.60	24.95	23.73	35.30	6.60
Mean	5.69	7.34	7.21	8.69	
		$LSD_{0.05}$	Variety (V)	= 0.17	
		Increase in light period (P)		= 0.24	
		P X V		= 0.34	

Mean Bulb-Length: The mean bulb length increased with increasing light extension, ranging from 4.31 cm in the control to 5.76 cm at 6-hour period of light extension and the difference was significant (P<0.05) (Table 1). The mean bulb length increased with increasing photoperiod up to 6 hour exposure to light in the variety "Red Creole". In the variety "Violet de Galmi", however, the bulb length increased with increasing photoperiod up to 2-hour exposure and thereafter (Table 5).

Table 5: Effects of Variety and Increase in Day-Length (Light Period) 0n Mean Bulb Length (cm) of the Onion Varieties during the 2007 and 2008 Planting Seasons

	Increase in light period				
Verity	**0**	**2**	**4**	**6 (hr)**	**Mean**
Violet de Galmi	16.65	20.95	18.91	23.05	4.97
Red Creole	17.86	18.38	21.20	23.00	5.03
Mean	4.31	4.92	5.01	5.76	
		$LSD_{0.05}$	Variety (V)	= 0.15	
		Increase in light period (P)		= 0.22	
		P X V		= 0.31	

Mean Number of Rings per Bulb: The mean number of rings per bulb ranged from 6.13 in the control to 10.25 at 6-hour period of light extension and the difference was significant (P<0.05) (Table 1). In both varieties "Red Creole" and "Violet de Galmi", the mean number of rings per bulb increased with increasing light period, but the difference was not significant (P<0.05) (Table 6).

Table 6: Effects of Variety and Increase in Day-Length (Light Period) 0n Mean Number of Rings per Bulb of the Onion Varieties during the 2007 and 2008 Planting Seasons

	Increase in light period				
Verity	**0**	**2**	**4**	**6**	**Mean**
Violet de Galmi	26.00	38.00	32.00	40.00	8.50
Red Creole	23.00	30.00	33.00	42.00	8.00
Mean	6.13	8.50	8.13	10.25	
		$LSD_{0.05}$	Variety (V)	= 0.46	
		Increase in light period (P)		= 0.65	
		P X V		= 0.92	

DISCUSSION AND CONCLUSION

The increase in weight, size, diameter, length and the mean number of rings per bulb with increasing light period in this study could be attributed to increased photosynthetic activity in the leaves of the plants. Light is one of the major factors required for efficient photosynthesis, which results in the production of organic substances (carbohydrates and proteins) needed for growth and development of plant parts and storage organs. Cell division, multiplication and expansion result from increased photosynthetic activity. The photosynthetic activity in turn results in the production of assimilates which are stored in harvestable organs like bulbs and roots. Although the two varieties responded positively to increased period of light extension, the variety "Red Creole" responded to longer photoperiods in the onion bulb length by 5.03 cm compared to the 4. 97 cm obtained in the variety "Violet de Galmi". Antonio and Costa (2003) reported a wide range of genetic variability among the onion varieties, which could be responsible for the differences obtained between the two varieties in this study. The formation and maturation of bulbs in the onion have been reported to be influenced by the environment and genotype (Jones and Mann, 1963; Costa, 1995), as was observed in this study.

Apart from the length of bulb, the variety "Violet de Galmi" exceeded the variety "Red Creole" in all the parameters observed in this study, indicating, perhaps, that the former is more suited for cultivation in the Jos-Plateau environment than the latter. This study also showed that, the yield of onion bulb could be higher in the tropics where light period is longer than in the temperate environment with shorter day length.

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