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Hybrid lilies under bulb removal stress

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The effect of bulb removal stress on vegetative and flower development of four hybrid lilies at different growth stages and their tolerance to this stress were investigated in this experiment. The tested hybrids were "Royal show" (LA hybrid), "White heaven" (L. longiflorum hybrid), "Sorbonne" and "Premium blond" (Oriental hybrids), four treatments included the bulbs were not removed (control) or removed two, four and eight weeks after planting weeks after planting (WAP) for all cultivars. The results showed that the bulb removal stress had adverse effect on vegetative and flower development of lilies, but the degree of this effect was dependent on the date of bulb removal. It was decreased as the period between planting and bulb removal was increased. Therefore, this stress effect was high when the bulb was removed two weeks after planting (WAP) while it was low when the bulb was removed eight WAP. Thus, the plants at different growth stages have different tolerance levels against this stress and they can survive and successfully complete the life cycle even without their bulbs when these bulbs were removed at late growth stage. The results also showed that the tested cultivars exhibited different response and tolerance to this stress. However, the "Royal show" cultivar was the faster in growth, earlier for flowering and more tolerant with better adapted to bulb removal stress compared to other hybrids.

Key words: Hybrid lilies, vegetative and flower development, bulb removal stress**,** growth stage.

INTRODUCTION

Lilies are the most important cut flower in the flower market worldwide, therefore the hybridization continuously produce new cultivars by genetic crossings between lily species, these hybrids have a great commercial ornamental value in floriculture industry and can be classified into main groups: Asiatic hybrids, LA hybrids (they are a cross between *L. longiflorum* and Asiatic lily), Oriental hybrids and longiflorium hybrids *(L. longiflorum*), OT hybrids (they are a cross between Oriental and Trumpet lilies) and LO hybrid (they are a cross between *L. longiflorum* and Oriental lilies). These groups have many things in common but there are some differences between them, some related to their morphological, anatomical structures and developmental patterns, while others related to their growing and environmental conditions (Roh, 2011; Grassotti et al., 2011; van Tuyl and Arens, 2011).

In Lilium, bulb represent highly specialized storage

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organ which plays a vital role in the growth and development of plant and it is essential for replication and for survival in adverse environmental conditions. Several studies were carried out to investigate the relationship between the bulb as source and flower as sink; their results confirmed that the flower is considered as primary sink utilizes and consumes the assimilates which received from two sources: bulb scales and current photosynthesis of bottom leaves. Whereas, the role and function of bulb are greatly different at different growth and development stages, it serves as main source in early development stage to supply carbohydrate reserves to the shoots and flower buds, after that and before anthesis it becomes as combination of sink and source, consequently both bulb and flower are as sink at anthesis, later bulb becomes the main sink to receive and store carbohydrate reserves for next growth season (Addai et al., 2011; Addai, 2010; Wu et al., 2012a, b).

It believe that the approach of organ removal from plant is a useful tool for more investigating about the role of this organ in growth and development of the plant, therefore multiple experiments used flower buds, leaves, bulb scales and bulb as experimental material for this approach (Asker, 2012; Addai, 2010; Leclerc et al., 2005; Wang et al., 1992). It is well known that the plants are considered to be under stress when they are subjected to unfavorable growth conditions such as drought, salinity, heat stress, low light and more other kinds of stresses such as defoliation stress, deflowering stress. The stress has negatively effect on plant growth and yield of crops and caused a number of metabolic and developmental changes, in another side the plants under stress can perform some adaptation in different levels and in different defense mechanisms and ways such as behavioral, morphological, anatomical, physiological, and biochemical (Erik and David, 1996).

The purpose of the present study is to investigate the effect of bulb removal stress on vegetative growth and flower development of four hybrid lilies at different growth stages and to evaluate their response and tolerance to this stress.

MATERIALS AND METHODS

This experiment was conducted in the nursery of Floriculture Unit, Baghdad University, Iraq in October 2012 to January of 2013. vernalized bulbs of four lily hybrids including "Royal show" represents LA hybrids group, "White heaven", represents L. longiflorum hybrid group , "Sorbonne" and "Premium blond" represent oriental hybrids group (10 to 14 cm in circumference) were imported from the Netherlands. The bulbs were planted inside the plastic house of the nursery in cultivation beds containing peat-moss (peat-moss was obtained from Estonia; type H2-4,) and contains N: P: K- 14:16:18 fertilizer, lime, with pH value of (5.9). Planting was at 10 cm depth with 20 (cm) apart to promote development of stem roots, and the irrigation was manually. To remove the bulb from the plant, the stem was cut off carefully above the nose of the bulb without any effect to stem roots .The plant was re-planted again immediately after the bulb was removed; the dates of bulb removal were 2, 4 and 8 WAP (weeks after planting). The control treatment consisted of plants whose bulbs were not removed.

At blooming time, data of plant height (cm), number of flowers per plant and flower diameter (cm), number and weight (g) of leaves per plant were collected. Weeks taken for flower buds emergence at visible stage and weeks taken for first flower emergence at flowering time were noted as bud appearance time and as bloom time respectively.

This experiment was arranged in a completely randomized block design (CR-BD) and sixteen treatments used each treatment consisted of three replicates, and each replication consisted of 8 bulbs. Data were subjected to analysis of variance using Statistical analysis system (SAS) program and the mean separation was performed using Duncan's multiple range test at the 5% level of significance.

RESULTS

Plant height

The results in (Table 1) showed that the plant height (cm) at flowering was different as dependent on bulb removal date and cultivars. It varied from 12.58 to 80.58 cm. However, it was higher significantly in control treatment and lower in two weeks treatment compared to others in all cultivars. Plant height of four hybrids of lilies showed significant differences and the "Royal show" cultivar had the tallest plants

Leaves number and weight

The results (Tables 2 and 3) showed that the number and weight (g) of leaves per plant at flowering was different as dependent on bulb removal date and cultivars. It varied from 20.92 to 68.17 per plant (number), and from 4.59 to 52.33 per plant (weight).However, the number and weight (g) of leaves was higher significantly in control treatment and lower in two weeks treatment compared to other treatments. The number and weight of leaves differed significantly among the hybrids of lilies and the LA hybrid lily "Royal show" showed the highest number and weight of leaves.

Flowers number

The flower number per plant showed significant differences as dependent on bulb removal date and cultivars (Table 4). It varied from 0.0 to 4 per plant. However, it was higher significantly in control and eight weeks treatments compared to others, and the flower buds formation was inhibited as a result of two weeks bulb removal treatments in all cultivars.

The number of flowers per plant differed significantly among the hybrids of lilies and the LA hybrid lily "Royal show" showed more flowers per plant compared to other cultivars.

Table 1. Effect of bulb removal date on the plant height (cm) in hybrid lilies.

Time of bulb removal		Plant height (cm)				
		Cultivars				
Weeks after planting		**Royal show**	**White heaven**	**Premium blond**	**Sorbonne**	**Mean**
Two		27.38	12.58	28.58	24.00	23.14
Four		41.33	21.42	38.54	39.30	35.15
Eight		74.75	49.04	64.08	66.45	63.58
Control (bulb not removed		80.58	59.71	70.71	71.75	70.69
Mean		56.01	35.69	50.48	50.38	
LSD	Times		1.608			
	Cultivars		1.608			
	Time ×cultivar		3.216			

The mean separation was performed using Duncan's multiple range tests at the 5% level of significance.

Table 2. Effect of bulb removal date on the number of leaves per plant in hybrid lilies.

Time of bulb removal (weeks after planting)		No. of leaves				
		Cultivars				
		Royal show	**White heaven**	**Premium blond**	**Sorbonne**	**Mean**
Two		52.71	20.92	26.08	25.63	31.33
Four		55.58	29.33	34.38	30.88	37.54
Eight		66.46	31.21	34.88	31.04	40.89
Control (bulb not removed)		68.17	33.54	36.92	32.58	42.80
Mean		60.73	28.75	33.06	30.03	
LSD	Times		1.596			
	Cultivars		1.596			
	Time ×cultivar		3.192			

The mean separation was performed using Duncan's multiple range tests at the 5% level of significance.

Table 3. Effect of bulb removal date on the weight of leaves (g) per plant in hybrid lilies.

Time of bulb removal		No. of flowers				
		Cultivars				
Weeks after planting		**Royal show**	**White heaven**	**Premium blond**	**Sorbonne**	**Mean**
Two		10.83	4.59	5.88	8.00	7.32
Four		35.07	22.45	23.02	24.30	26.21
Eight		36.31	30.31	29.84	31.46	31.98
Control (bulb not removed)		52.33	37.08	36.10	35.99	40.37
Mean		33.63	23.61	23.71	24.94	
LSD	Times		0.515			
	Cultivars		0.515			
	Time ×cultivar		1.029			

The mean separation was performed using Duncan's multiple range tests at the 5% level of significance.

Flower diameter

The flower diameter (cm) was different as dependent on bulb removal date and cultivars (Table 5). It varied from 0.0 to 22.54 (cm) among the treatments. However, the plants of control and eight weeks treatments produced significantly larger flowers compared to the plants of other treatments. The diameter of flowers differed

Table 4. Effect of bulb removal date on the number of flowers per plant in hybrid lilies.

Time of bulb removal		Wt. of leaves (g)				
		Cultivars				
Weeks after planting		**Royal show**	**White heaven**	**Premium blond**	**Sorbonne**	**Mean**
Two		0.00	0.00	0.00	0.00	0.00
Four		3.50	0.00	2.00	2.50	2.00
Eight		3.83	1.00	2.58	3.75	2.79
Control (bulb not removed)		4.00	1.00	2.80	3.83	2.91
Mean		2.83	0.50	1.84	2.52	
LSD	Times		0.152			
	Cultivars		0.152			
	Time ×cultivar		0.304			

The mean separation was performed using Duncan's multiple range tests at the 5% level of significance.

Table 5. Effect of bulb removal date on flower diameter (cm) in hybrid lilies.

Time of bulb removal		Flower diameter (cm)				
		Cultivars				
Weeks after planting		**Royal show**	**White heaven**	**Premium blond**	**Sorbonne**	**Mean**
Two		0.00	0.00	0.00	0.00	0.00
Four		16.30	0.00	17.50	15.96	12.45
Eight		17.42	17.00	21.67	17.04	18.28
Control (bulb not removed)		18.63	17.50	22.54	21.38	20.01
Mean		13.09	8.63	15.43	13.59	
LSD	Times		0.221			
	Cultivars		0.221			
	Time ×cultivar		0.441			

The mean separation was performed using Duncan's multiple range tests at the 5% level of significance.

significantly among the tested hybrids of lilies. The flowers of Oriental hybrids "premium blond" and "Sorbonne" were larger than other cultivars.

DISCUSSION

The results indicated that the development of above-ground organs of plant was greatly affected by bulb removal stress which caused limited in vegetative growth and flower development and that probably due to the removal of bulb resulting in loss of the major source for carbohydrate reserves which caused the plant development processes to depend only on the assimilates received from current photosynthesis. But the degree of this stress effect varied among treatments depending on the growth stage at which the bulbs were removed and it was decreased as the period between planting and bulb removal was increased. Therefore this effect was high when the bulb was removed two WAP while it was low when the bulb was removed eight WAP and that probably due to this stress associated with the potential changes in the role of bulb in plant development during the whole life cycle of the plants. This could be explained, the tolerance of plant to bulb removal stress was lower at early stage of growth when the bulb was the main source to supply assimilates for development whereas it was higher at late growth stage when both bulb and leaves were serve as source or when leaves was as source and bulb was as sink (Addai et al., 2011; Addai, 2010; Wu et al., 2012a, b), therefore the plants can successfully complete the development processes even in the absence of their bulb at late growth stage.

The time of buds appearance at visible buds stage was different as dependent on cultivars. LA hybrid lily took the shortest period (5 weeks) while oriental hybrid lilies took the longest period (8 weeks). The flower buds did not appeared in all plants of two weeks treatment. The time (weeks) from planting to flowering was also different among the hybrid lilies. LA hybrid lily " Royal show " took the shortest period (11 weeks) while oriental hybrid lilies took the longest period (15 weeks), thus, the LA hybrid

lily "Royal show" showed faster in growth, earlier in flowering and also was more tolerant and better adapted to bulb removal stress compared to other hybrids whereas oriental hybrid lily bloomed later than other types of Lilium with larger flowers.

These results indicated that the lily plants under bulb removal stress have a potential defense response and they can survive without their bulb, but that dependent on growth stages of the plants when the bulbs were removed and on cultivars.

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