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Effect of Plant Growth Regulators (IBA, BA, and CCC) on Some Flowering Characters of Three Hybrid Lily Cultivars of (*Lilium spp.* L.)

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Abstract

The present study was conducted in the nursery of Floriculture Unit, University of Baghdad in Iraq during September to December of 2013. Vernalized bulbs of hybrid lily cultivars were imported from the Netherlands. The experiments were included some hybrid lily cultivars which represent the main groups of lily (longiflorum hybrids, Asiatic hybrid and trumpet hybrids). The three lily cultivars named as Tiger (Oriental), Brunello (Asiatic) and White Heaven (Longiflorum) were sprayed two times, at five weeks after planting and at eight weeks after planting with a solution of Cycocel (100 mg /l), solution of Indole butyric acid (50 mg/l) and Benzyl adenine (50 mg /l). The results indicated that foliar spray with IBA lead to decrease in flower diameter in White heaven, increase in fresh and dry weight of bulbs and decrease the time required to flowering in Tiger Edition. BA led to increase in the time required for flowering and decrease in the flower number in Brunello, in Tiger Edition led to increase in dry weight of bulbs, while in White Heaven led to increase dry and fresh weight of bulbs with a decrease in flower diameter. While foliar spray with CCC led to increase in dry and fresh weight of bulbs and flower number in Tiger Edition, in Brunello led to increase in fresh weight of the bulbs and carbohydrate content of the bulbs ,in White Heaven led to increase in fresh and dry weight of the bulbs and carbohydrate content in bulbs.

Keywords: *Lilium*, IBA, BA, CCC, Flowering characters.

تأثير منظمات النمو (IBA و BA و CCC) في بعض الصفات الزهرية لثلاثة اصناف مهجنة من ال *Lilium spp.* L.

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الخلاصة

نفذت تجربة في مشتل جامعة بغداد ،العراق. خلال الفترة من ايلول الى كانون الاول 2013. تم استيراد ابصال لأصناف مختلفة من الليليوم من هولندا.هذه الابصال تابعة للمجاميع (Longiflorum hybrids ، Asiatic hybrids و Trumpet hybrids). رشت ثلاث اصناف وهي Tiger ,(Asiatic) Brunello White Heaven (Longiflorum), (Oriental) مرتين في الاسبوع الخامس و الاسبوع الثامن من الزراعة ب 100 ملغ/لتر من ال Cycocel، 50 ملغ/ لتر من Benzyl adenine و 50 ملغ/ لتر من ال . Indole butyric acid بينت النتائج ان الرش بال IBA ادى الى تقليل اقطار الازهار في صنف ال White heaven و زيادة في الوزن الجاف و الرطب للابصال و نقصان في الوقت اللازم للازهار في صنف ال Tiger Edition.ان الرش بال BA ادى الى زيادة بالوقت اللازم للازهار ونقصان بعدد الازهار في ال Brunello. و زيادة بالوزن الجاف للابصال بال Tiger Edition . وأدت ايضا الى زيادة بالوزن الجاف

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والرطب للابصال ونقصان بقطر الازهار في ال White heaven. بينما لوحظ ان الرش بال CCC ادى الى زيادة بالوزن الجاف و الرطب للابصال بال White heaven.كما ادى الى زيادة الوزن الرطب والمحتوى الكاربوهيدراتي للابصال في ال Brunello مما أدى الى زيادة بالوزن الجاف و الرطب والمحتوى الكاربوهيدراتي للابصال و عدد الازهار في ال Tiger Edition.

Introduction

The genus *Lilium* belongs to family Liliaceae and comprises over 80 species [1]. Hybrid lilies are excellent cut flowers [2], highly prized by horticulturists because of their outstanding fragrance, a range of colors, hardiness and adaptability to diverse environmental conditions [3]. Lily has been used for different purposes including bouquet formation, decoration of hotels, houses, luxury buildings, marriages, funeral and religious ceremonies for over 2000 years[4].

The most important factor determining the market of Lilium flower value is the accuracy and uniformity with which the crop flowers in time for sales. Plants that do not flower immediately are not marketable. In contrast, plants that flower too early must be held in coolers until the market date, adding substantial production costs while reducing quality [5]. Also color considered one of the most important characters in combination with flower shape and size [1].

Foliar application of nutrients and plant growth regulators may improve flower quality parameters [6]. Stem length control also required in order to obtain bulb plants that are proportional to their pot size and to reduce post- harvest stem elongation [7]. An effective means of controlling plant height is using plant growth regulators [8].

Several studies in overseas showed the effective role of cycocel, indole butyric acid and benzyl adenine on vegetative and flowering characters [9-11]. However, little attention has been drawn to the effect of plant growth regulators on the lilies in the world particularly in Iraq. Therefore, this study aiming to improve flowering characters of hybrid lily cultivars by using plant growth regulators.

Materials and Methods

In this experiment the bulbs of three hybrid lily cultivars ; white heaven ,Brunello and Tiger Edition (14 to 16 cm in circumference) were potted inside the plastic house of the nursery. Each cultivar imposedto four treatment (without any plant growth regulator), indole butyric acid (IBA), benzyl adenine (BA) and cycocel (CCC).

The whole plant was sprayed two times, first at five weeks and second at eight weeks after planting. The solution of CCC (100 mg /l), solution of IBA (50 mg/l) and BA (50 mg /l) were applied by foliar spray until obvious drops appeared on the leaves. Water was not applied for plant on three days after each application.

The preparation of plant growth regulators

1. Cycocel: 100 mg of CCC dissolved in 1000 ml of distal water.
2. IBA: 50 mg of IBA dissolved in 5 ml of NAOH (5 g of NAOH /250 ml of distal water) and then completed to 1000 ml by distal water.
3. BA: 50 mg of BA dissolved in 5 ml of HCL (8 ml of HCL / 1000 ml distal water) and then completed to 1000 ml by distal water.
4. The control treatment used D. water of foliar spray.

Morphological Parameters

During the period of this experiment the bulbs were monitored and the data were collected as follows:

1. Number of buds: The number of visible buds in each plant during three stage of bud growth (appearance, enlarging and coloring) was recorded (average of all replications).
2. Diameter of buds (cm) per plant: the diameter of bud was measured in the mid region of bud by vernier. The measured was made during three stages of bud growth (appearance, enlarging and coloring), (all replications for each treatment).
3. Number of flowers: the number of flowers on plant by each replicate was recorded and averaged.
4. Diameter of flowers (cm) per plant (all replications for each treatment).
5. Days were taken for plant appearance, flower bud appearance at visible stage, flower bud coloring, the first flower appearance at flowering time and flowering period by days.
6. Total fresh weight, total dry weight, fresh and dry weight of bulb.

Experimental Design and Analysis

This experiment was arranged in a completely randomized design (CRD). Each treatment consisted of three replications, and each replication consisted of five bulbs. Data were subjected to analysis of variance using statistical analysis system (SAS) program [12] and the separation was performed using least significant differences test (LSD) to compare the differences between treated and un treated plants, at the 5% level of significance.

Result and Discussion

Flower Diameter

According to the results, IBA decrease flower diameter and flower bud diameter of White Heaven by 28% and 24% respectively (Tables-1,-2). Auxins have been flowering inhibitory role in short photoperiodic plant. The maximum inhibiting effect appeared if the plant treated in the beginning of a dark period [13]. This effect disagrees with the results of Al-Hasnawi [14] who observed that foliar spray with 50 mg/l of IBA increased flower diameter of *Zinnia haageana*. Ziaullah et al. [10] showed that treated of stem cuttings of marigold with 100 mg/l of IBA increased their flower diameter. Al-Sahn [15] also recorded that foliar spray with 50 mg/l of IBA significantly increased flower diameter *of Dianthus caryophyllus* L. This effect may be due to differences in PGRs concentration, or time of application, the plant type or differences in environmental factors [13].

BA caused a decrease in flower diameter in White Heaven and flower bud diameter by 27 and 22% respectively (Tables-1,-2). This effect is in agreement with Carey *et al.* [11] who indicated that foliar spray of exilis plus 40 ppm lead to decrease in flower diameter of petunia. This result disagrees with Al-Hasnawi [16] who found an increase in flower diameter of *Chrysanthemum hortorum* Hort. by spraying with 50 mg/l of BA. AL-Abbasi [17] also found an increase in flower diameter of *Dianthus caryophyllus* L. as response to Kinetin application. Flower diameter and flower bud diameter had no affected by foliar spray with CCC (Tables-1,-2).

Table 1- Effect of IBA, BA, and CCC on flower diameter

	White Heaven	Brunello	Tiger Edition	Mean
Control	16.00	12.33	15.66	14.66
IBA	11.50	13.50	15.66	13.55
BA	11.66	13.50	15.33	13.49
CCC	16.70	13.60	15.66	15.32
L.S.D. ≤ 0.05	2.64			1.49
Average	13.96	13.23	15.58	---
L.S.D. ≤ 0.05	1.27			

Table 2- Effect of IBA, BA, and CCC on flower bud diameter

Hybrids / PGRs	White Heaven	Brunello	Tiger Edition	Mean
Control	3.12	2.13	1.43	2.23
IBA	2.37	2.17	2.53	2.35
BA	2.42	1.96	1.50	1.96
CCC	3.23	2.52	1.52	2.42
L.S.D. ≤ 0.05	1.64			NS
Average	2.78	2.19	1.75	---
L.S.D. ≤ 0.05	0.882			

Flower Number

Brunello gave a higher flower number and flower bud number compared to other hybrids (tables 3,4). Foliar spray with a BA decrease flower number of Brunello by (27.91%) (Table-3). Cytokines effect on apical dominance of the stem by inhibiting the effect of apical bud which inhibit the lateral bud growth [18].

CCC increased flower number of Tiger Edition by 30% and bud flower number by 18% (Tables-3,-4). Cycocel lead to accumulation of photosynthetic products in a plant and then increase the carbohydrate level [17]. This effect agrees with AL-Abbasi [17] by his study on *Dianthus caryophyllus* L. He observed an increase in flower number due to treatment with CCC. Marosz [19] also observed

increase in flower bud number of *Azalea* cvs. Cannon‟s Double and Kilian due to Foliar spray of CCC at 100-1000 mg/l. While disagreeing with Bhat *et al.* (3) that showed no effect of CCC on flower number of *Erysimum marshallii* (Henfr.) Bios. this is due to the different response of plants to plant growth regulators.

Total carbohydrate in the tepals of each bud plays an important role in the development of the buds to anthesis [20]. This led to the suggestion that bud plasting is due to a lack of carbohydrate (21). Therefore the decrease or increase of total carbohydrate in the leaf may be effected on the carbohydrate content in bud and then effect on flower number and diameter.

Table 3- Effect of IBA, BA, and CCC on flower number.

Hybrids / PGRs	White Heaven	Brunello	Tiger Edition	Mean
Control	3.40	5.66	3.08	4.04
IBA	3.30	6.30	3.00	4.20
BA	3.42	4.08	3.50	3.67
CCC	3.86	6.09	4.00	4.65
L.S.D. ≤ 0.05	2.17			NS
Average	3.49	5.53	3.39	---
L.S.D. ≤ 0.05	1.19			

Table 4- Effect of IBA, BA, and CCC on flower bud number.

Hybrids / PGRs	White Heaven	Brunello	Tiger Edition	Mean
Control	3.80	6.53	3.40	4.57
IBA	3.73	6.80	3.15	4.56
BA	3.93	6.66	3.66	4.75
CCC	4.28	6.80	4.00	5.02
L.S.D. ≤ 0.05	2.47			NS
Average	3.93	6.69	3.55	---
L.S.D. ≤ 0.05	1.56			

Flowering Time

According to the results, foliar spray with IBA decreased the days to flowering in Tiger Edition by (8.97%) (Table-5). Auxin has an important role in the photosynthetic process to increase leaf area and chlorophyll content. This may increase elements in the plant lead to earliness in flowering [14]. Such effect agree with Al-Hasnawi [14] who observed significant decrease in the time required for flowering by a spray of IBA. Al-Sahn [15] also observed decrease in the time required for flowering on *Dianthus caryophyllus* L. due to spray with IAA.

Foliar spray with BA increased this trait in Brunello by (12.50%) (Table-5). This increase may be due to the interference between cytokines and other internal hormones lead to retarded the flowering. This increase agrees with AL-Abbasi [17] found increasing in the time required for flowering in *Dianthus caryophyllus* L. due to treated with kinetin. While Nambiar *et al.* [22] observed a decrease in the time required for flowering in *Dendrobium* orchid due to treatment with 80 mg/l of 6-Benzylaminopurine.

CCC did not effect on this character on all three hybrid lilies (Table-5). This result agrees with Dhiman (23) who found that pre plant bulb of LA Hybrid (Cilesta) dips with paclobutrazol (anti gibberellins) had no effect on the time required to flowering. Plant growth regulators did not show any significant effect on others stages of lilium life (Table-5). Plant Tiger Edition needs more days to appear compared to other hybrids.

Table 5- The effect of IBA, BA, and CCC on the growth stages of *Lilium.*

Cultivars	PGRs	Plant appearance (days)	Bud appearance (days)	Bud coloring (days)	Flowering (days)	Flowering end (day)
White Heaven	Control	5	64	85	92	106
	IBA	5	64	82	90	104
	BA	5	64	86	92	111
	CCC	5	64	85	92	104
LSD ≤ 0.05		NS	NS	NS	NS	NS
Brunello	Control	5	36	69	72	96
	IBA	5	36	70	76	97
	BA	5	36	74	81	100
	CCC	5	36	70	76	97
LSD ≤ 0.05		NS	NS	NS	6.426 *	NS
Tiger Edition	Control	22	55	70	78	98
	IBA	22	60	66	71	99
	BA	22	60	68	77	102
	CCC	22	55	67	76	93
LSD ≤ 0.05		NS	NS	NS	6.004 *	6.419 *

Fresh Weight of Bulbs

Treatment with foliar spray containing IBA increased the fresh weight of the bulbs in Tiger Edition by (148.22%) (table-6). This increase agrees with Kurtar and Ayan [24] who observed an increase in bulb weight of Tulip (*Tulipa gesneriana* Var. Cassini) due to spray with 500 ppm of IAA.

Foliar spray with BA increased this trait in White Heaven by (57.66%) (table-6). White Heaven increased by (90.81%), Brunello by (22.81%), and Tiger Edition by (281.11%) due to foliar spray with CCC (table 6). This increase agrees with Taha [25] who reported that the bulb weight of Iris plants increasing by using 250 ppm of CCC. Zheng *et al*. [26] was in agreement with these results. They observed an increase in bulb weight of *Lilium* Oriental hybrids 'Sorbonne' treated with 300 mg/l of CCC. Bulb size at planting influenced vegetative growth and all other parameters measured in lily. As the size of the planted bulb increased, parameters measured also increased in proportion to the size of the planted bulb [27]. So this increase in the bulb helps in the plant growth in the next year. In addition to Large bulbs producing more numbers of saleable bulbs and flowers compared with smaller ones [28].

Table 6- Effect of IBA, BA, and CCC on fresh weight of bulb after flowering.

Hybrids / PGRs	White Heaven	Brunello	Tiger Edition	Mean
Control	16.44	23.36	4.50	14.77
IBA	20.02	23.95	11.17	18.38
BA	25.92	26.38	5.70	19.33
CCC	31.37	28.69	17.15	25.73
L.S.D. ≤ 0.05	11.68			7.84
Average	23.44	25.59	9.63	---
L.S.D. ≤ 0.05	6.52			

Dry Weight of Bulbs

According to the results, foliar spray with IBA increased dry weight of the bulbs in Tiger Edition by (356.25%) (table-7). Foliar spray with BA increased this trait in Tiger Edition by (112.50%) and White Heaven by (83.83%) (table-7).

In addition to increase the dry weight of bulbs in White Heaven by (137.37%) and Tiger Edition by (714.58%) by spraying with CCC (table-7). This increase may be due to increase of carbohydrate accumulation in bulb, this increase help bulb to re grow after one year. The bulb depends on stored carbohydrate to growth until the leaf appearance and become able to photosynthesis. Leaves at this stage supply stem, root, flowers and even bulb in nutrient material [27]. Plants from larger bulbs produced more flower buds, since bulbs are underground carbohydrate storage structures and larger bulbs had more energy reserves[29].

Table 7- Effect of IBA, BA, and CCC on dry weight of bulb after flowering.

Hybrids / PGRs	White Heaven	Brunello	Tiger Edition	Mean
Control	3.96	7.38	0.48	3.94
IBA	4.28	6.77	2.19	4.41
BA	7.28	7.56	1.02	5.28
CCC	9.40	8.60	3.91	7.30
L.S.D. ≤ 0.05	3.75			2.92
Average	6.23	7.57	1.90	---
L.S.D. ≤ 0.05	2.46			

Conclusion

From these results, Brunello was more responsive to PGRs. CCC more PGRs affected on lily hybrids. Foliar application with IBA and CCC gave more effect on vegetative growth than flowering growth. Foliar application of BA gave negative effect on flowering growth.

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