Influence of Growth-Regulating Chemicals on *Hippeastrum hybridum* hort.

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Abstract

The effect of bulb-dip application of each of the following – chlormequat chloride (CCC), daminozide (B-Nine), etephon (Ethrel), maleic hydrazide (MH), triiodobenzoic acid (TIBA), indole-acetic acid (IAA), gibberellic acid (GA_3) and naphthylacetic acid (NAA) – was studied on growth, flowering and bulb formation of *Hippeastrum hybridum*. CCC and B-Nine induced early sprouting of bulbs, delayed flowering, increased the size and longevity of flowers, accelerated bulb production and improved the quality of bulbs in size and weight. Longer flower spikes were obtained with B-Nine-treated bulbs. Ethrel and MH delayed sprouting, but induced early flower-bud appearance and increased longevity of flowers. Beneficial effects on bulb formation with Ethrel was also recorded, while MH, NAA and TIBA were ineffective. IAA and GA_3 promoted vegetative growth, induced early flowering, stimulated flower size and stalk length, yielded a greater number of flowers per stalk, extended longevity of flowers, increased bulb production, and improved the size and weight of bulbs.

Introduction

Hippeastrum hybridum is one of the well known bulbous ornamental plants, which produces attractive lily-like flowers on long stalks. This most popular spring- and summer-flowering plant is commercially grown in the Netherlands and exported to different countries. Synthetic growth-regulating chemicals are being increasingly used to manipulate growth and flowering of bulbous plants. These chemicals offer a broad range of effects, both morphological and physiological. Stem elongation of *Lilium* cultivars has been effectively reduced by soil drench of CCC (Pearse, 1972), ancymidol (Dicks and Rees, 1973), Ethrel (Wade, 1972) and Phosphon (chlorphonium chloride) (Stuart *et al.*, 1961). Bhattacharjee *et al.* (1976) reported that in dahlia, treatment with GA_3 increased the number of flowers, and with IAA and GA_3, promotion of shoot length. Application of IAA increased the corm weight of gladiolus, whereas GA_3 treatments increased the weight of cormels (Winkler, 1969). In the present investigation an attempt has been made to evaluate the effectiveness of different growth-regulating chemicals on growth, flowering and bulb formation of *Hippeastrum hybridum*.

Materials and Methods

Experiments were conducted at the Institute in Hessarghatta, Bangalore during 1981-1982. *Hippeastrum hybridum* bulbs of uniform size and weight were soaked for five hours in different growth regulating chemicals prior to planting in September 1981. The untreated bulbs of the control were soaked in distilled water. The chemicals used were CCC and B-Nine at 1000, 2500 and 5000 ppm of each; Ethrel, MH and TIBA at 500, 1000 and 2000 ppm of each; and IAA, GA_3 and NAA at 10, 100 and 1000 ppm of each. The soaked bulbs were then dried in the shade

in open air for eighteen hours. Thereafter the bulbs were planted in 25-cm earthenware pots, one in each, in a pot mixture of one part each of sand, soil, leaf mould and farm yard manure. A mixed fertilizer at the rate of 25 gms per pot was also added, irrespective of the treatment. The experiment was laid out in a completely randomised design, involving twenty-five treatments. Five pots were kept for each treatment. Observations were taken on vegetative growth, flowering and bulb formation. Data on bulb formation was collected by carefully removing the bulb and bulblets at the cessation of vegetative growth, twelve months after planting.

Results and Discussion

Sprouting of bulbs. In both the control and the treated ones there was 100% sprouting with all the treatments including the untreated control. Days taken for sprouting of the treated bulbs varied with the chemicals and their concentrations. At all concentrations, B-Nine and CCC significantly induced advanced sprouting by 12.2 to 20.0 days over the control. The lowest concentration of Ethrel, GA_3 and NAA also exhibited earlier sprouting of bulbs by 3.4 to 5.2 days. Treatments with MH and TIBA, and NAA at 1000 ppm delayed sprouting to a great extent. For inhibition of sprouting of storage tubers of potato and bulbs of onion, MH is largely used (Skoog, 1980). Junges (1964) and Rudinicki *et al* (1976) reported early sprouting with the application of GA_3 in *Freesia hybrida* and tulips respectively (Table 1).

Vegetative growth. It was observed that the highest concentration of Ethrel and NAA, and treatments with MH and TIBA markedly retarded leaf length. Maximum retardation was obtained with TIBA at 2000 ppm, and the percentage of retardation was 37.09 over the control. The lowest concentration of CCC, B-Nine and NAA, all concentrations of GA_3 and IAA at 100 and 1000 ppm promoted leaf length appreciably. Promotive effect was greater with GA_3, and the highest accleration, exceeding 27.33 per cent over the control, resulted with GA_3 at 1000 ppm. Application of MH inhibited growth of Croft Easter lilies (Struckmeyer and Beck, 1952). Dicks and Rees (1973) observed height reduction in *Lilium* with Ethrel at 1000 ppm. Promotion of plant height with GA_3 in Mid-Century Hybrid Lily was reported by Dicks *et al* (1974). The number of leaves per plant increased significantly with CCC at 1000 ppm, GA_3 and IAA at 100 ppm of each. An increase in the number of leaves of *Hippeastrum hybridum* with the application of IAA and GA_3 was also reported by Bose *et al.* (1980). Though the number of side shoots per plant due to the treatments with growth-regulating chemicals had not affected significantly, treatments with CCC at 1000 ppm, and GA_3 and IAA at 100 ppm of each considerably stimulated the production of a greater number of the side shoots (Table 1).

Bulb yield. The application of chemicals increased bulb yield, in general, except with NAA at 100 ppm, IAA at 1000 ppm, TIBA at 500 and 2000 ppm. A significant rise in the production of bulbs was recorded with all concentrations of CCC, B-Nine, GA_3, IAA and MH. The two higher concentrations of Ethrel, two lower concentrations of IAA, and NAA at 10 and 1000 ppm, also showed appreciable improvement in bulb production (Table 1).

Bulb weight and diameter. The total weight of bulbs varied with the chemicals and concentrations. Among different chemicals only the two higher concentrations of TIBA, and NAA at 1000 ppm significantly reduced the bulb weight. Increase in the total weight of bulbs varied from 2.69 to 72.31 per cent. over control with the treatments of CCC, B-Nine, Ethrel, GA_3, NAA, IAA and MH. Maximum beneficial effect was seen with the two lower concentrations of CCC, B-Nine and GA_3. Diameter and weight of the largest bulb markedly increased with all concentrations of CCC

Table 1

Effect of Growth Regulating Chemicals on Vegetative Growth and Bulb Formation of *Hippeastrum Hybridum* hort.

TREATMENT	(ppm)	BULBS days for sprouting	LEAF length (cm)	LEAVES number	SIDE SHOOTS number	BULBS total number	BULBS total weight (gms)	LARGEST BULB diameter (cm)	LARGEST BULB (weight (gms)
Control		45.2	46.1	7.2	1.2	2.0	115.2	5.6	104.9
CCC	1000	30.4	53.1 (15.18)	9.2	2.0	3.0	195.5 (72.31)	7.5	185.0
CCC	2500	31.8	49.4 (7.16)	8.2	1.4	3.0	160.7 (39.49)	7.0	147.6
CCC	5000	33.0	47.4 (2.82)	8.0	1.6	3.8	150.2 (30.38)	6.8	139.0
B-Nine	1000	25.2	52.3 (13.45)	7.6	1.2	3.2	190.5 (65.36)	7.0	180.0
B-Nine	2500	27.2	48.3 (4.77)	8.0	1.4	4.8	165.8 (43.92)	6.5	145.0
B-Nine	5000	29.2	49.3 (6.94)	7.6	1.6	3.0	128.5 (11.55)	6.6	115.0
Ethrel	500	40.0	44.2 (−4.12)	8.0	1.0	2.6	125.5 (8.94)	6.0	110.0
Ethrel	1000	57.6	42.4 (−8.03)	8.0	1.4	3.6	148.8 (29.17)	6.0	133.8
Ethrel	2000	75.0	39.4 (−14.53)	7.6	1.6	3.6	138.2 (19.99)	5.9	128.0
MH	500	56.6	41.4 (−10.19)	7.4	1.4	5.8	125.5 (8.94)	5.8	110.0
MH	1000	64.0	36.0 (−21.90)	6.4	1.0	3.8	110.1 (−4.43)	5.4	98.0
MH	2000	67.2	35.0 (−24.08)	7.2	1.0	5.0	105.8 (−8.16)	5.5	90.0
TIBA	500	66.0	36.2 (−21.48)	8.0	1.4	2.0	102.1 (−11.37)	5.4	94.0
TIBA	1000	84.0	32.0 (−30.59)	6.0	1.0	2.8	85.8 (−25.52)	5.0	68.0
TIBA	2000	86.0	29.0 (−37.09)	5.6	1.0	1.0	66.1 (−42.62)	5.1	66.1
IAA	10	44.0	49.3 (6.94)	7.6	1.6	3.0	134.3 (16.58)	6.0	112.0
IAA	100	43.4	52.3 (13.45)	9.0	2.0	3.8	140.2 (21.70)	5.9	122.0
IAA	1000	48.8	53.3 (15.62)	7.4	1.4	2.0	118.9 (3.21)	6.2	112.0
GA_3	10	40.0	55.2 (19.73)	8.2	1.4	4.4	175.5 (52.34)	7.0	160.0
GA_3	100	42.0	57.5 (24.7)	10.0	2.6	3.8	193.3 (67.91)	7.5	161.6
GA_3	1000	46.2	58.7 (27.33)	8.0	1.6	3.2	145.2 (26.04)	6.0	125.7
NAA	10	41.8	51.7 (11.71)	7.2	1.4	3.4	120.8 (4.86)	5.9	105.1
NAA	100	50.0	47.4 (2.82)	6.4	1.0	2.0	118.3 (2.69)	5.8	105.1
NAA	1000	77.8	35.4 (−23.21)	6.2	1.0	3.2	75.4 (−34.55)	5.0	60.0
'F'-test		* *	* *	* *	N.S	* *	* *	* *	* *
S.Em		1.97	1.91	0.43	0.34	0.29	4.94	0.16	4.65
L.S.D. at 5%		5.54	5.39	1.19	-	0.81	13.90	0.44	13.07

* * — highly significant: N.S. — non significant.
Figures in the parenthesis indicate the percentage of increase or (−) decrease over control.

and B-Nine, GA_3 at 10 and 100 ppm. Halevy and Shilo (1970) reported that Ethrel on gladioli increased the yield of cormels. Application of GA_3 in *Begonia* increased the tuber weight (van Onsem and Haegeman, 1961). In tulips, Mohamed and Fawzi (1980) recorded an increase in the weight of mother and daughter bulbs.

Flowering. Advanced flower-bud appearance, by 22.0 to 79.8 days, was induced by treating with Ethrel, GA_3, IAA and MH. Application of CCC, B-Nine and NAA

Table 2

Effect of Growth Regulating Chemicals on Flowering of *Hippeastrum Hybridum* hort.

TREATMENTS	(ppm)	Days taken for initiation of ffb (= first flower bud)	Days from initiation of ffb to bud-opening	FLOWER SPIKES length (cm)	FLOWERS length (cm)	FLOWERS diameter (cm)	FLOWERS SPIKES number per plant	FLOWERS number per spike	Longevity of first-opened flower (days)
Control		150.2	23.2	30.2	10.0	12.5	1.0	2.0	5.2
CCC	1000	190.6	22.2	32.3 (6.95)	10.8	12.8	2.0	1.6	6.0
CCC	2500	205.2	24.0	34.3 (13.58)	12.6	16.5	1.2	2.8	6.2
CCC	5000	208.8	23.0	34.6 (14.57)	13.0	16.1	1.4	3.2	6.2
B-Nine	1000	203.8	22.2	45.3 (50.00)	12.0	16.1	1.2	2.6	6.2
B-Nine	2500	207.8	20.0	38.9 (28.81)	12.2	14.1	1.4	3.0	6.2
B-Nine	5000	212.8	21.0	43.0 (39.75)	12.1	14.6	1.0	3.2	5.4
Ethrel	500	70.4	23.8	27.2 (−9.32)	9.8	11.5	1.6	2.4	6.2
Ethrel	1000	85.2	23.8	24.1 (−20.19)	10.2	13.0	1.8	2.0	7.0
Ethrel	2000	88.8	23.0	25.2 (−16.52)	10.0	12.7	1.0	2.2	7.2
MH	500	98.8	25.8	28.4 (−5.92)	12.1	14.6	1.0	2.2	8.2
MH	1000	92.2	25.2	24.9 (−17.55)	12.1	15.0	1.0	2.0	8.0
MH	2000	81.4	26.2	23.1 (−23.50)	10.0	12.6	1.0	2.8	8.2
TIBA	500	160.8	28.8	20.3 (−32.78)	10.5	12.9	1.0	2.4	5.4
TIBA	1000	–	–	–	–	–	–	–	–
TIBA	2000	–	–	–	–	–	–	–	–
IAA	10	121.2	18.8	29.1 (−3.64)	12.0	15.4	1.6	3.0	6.2
IAA	100	119.0	18.0	36.0 (19.21)	12.6	15.4	1.0	3.8	6.0
IAA	1000	97.8	23.2	40.3 (33.44)	12.5	15.0	1.0	3.4	7.2
GA_3	10	120.4	20.0	34.9 (15.56)	12.0	15.4	1.4	3.6	6.2
GA_3	100	112.4	19.2	39.2 (29.80)	12.6	16.1	2.2	3.8	6.2
GA_3	1000	128.2	18.2	37.9 (25.49)	12.1	15.0	1.6	3.4	6.0
NAA	10	201.0	20.8	27.6 (−8.61)	10.5	13.6	1.0	2.6	5.2
NAA	100	218.2	19.0	25.1 (−16.89)	10.0	12.5	1.0	2.0	4.2
NAA	1000	216.2	20.2	25.1 (−16.89)	10.5	12.1	1.0	2.0	4.0
'F'-test		**	**	**	**	**	**	**	**
S.Em		4.64	0.55	1.26	0.35	0.67	0.16	0.20	0.29
L.S.D. at 5%		13.02	1.53	3.57	0.98	1.89	0.46	0.57	0.81

** — highly significant.
Figures in the parenthesis indicate the percentage of promotion or (−) retardation over control.

delayed flowering by 40.4 to 68.0 days. Treatment with TIBA at 1000 and 2000 ppm completely suppressed flowering. Flower-bud opening was also affected by the chemical treatments. All concentrations of GA_3 and NAA, and the two lower concentrations of IAA resulted in the early opening of flower buds. Flower-bud opening was delayed in MH and TIBA treatments (Table 2). Jansen (1960) reported early flowering in cyclamen with GA_3. Will (1977) observed that B-Nine delayed flowering in *gloxinia*. It was observed that treatment with CCC at 2500 and 5000 ppm, B-Nine and GA_3 at all concentrations, and IAA at 100 and 1000 ppm accelerated the flower-stalk length significantly, and the resulting acceleration from these treatments was 13.58 to 50.0 per cent. Higher concentrations of Ethrel and MH, and TIBA at 500 ppm reduced flower-stalk extension. Bose *et al* (1980) reported increase in flower-stalk length of *Hippeastrum* with IAA, GA_3 and CCC at 10 and 1000 ppm. Application of CCC, B-Nine, GA_3 and IAA, in general, and MH at 500 and 1000 ppm appreciably increased the length and diameter of flowers. The highest number of flower spikes per plant resulted with treatment with GA_3 at 100 ppm. The number of flowers per stalk also varied with the treatments, and the application of GA_3 and IAA, in general, showed the most beneficial effect. Treatments with the higher concentrations of CCC and all concentrations of B-Nine also induced a greater number of flowers per spike. The longevity of the first-opened flower was optimal with MH treatments. Treatments with CCC, B-Nine, Ethrel, GA_3 and IAA also extended the life of the first-opened flowers to a significant extent (Table 2). Sheehan and Joiner (1964–1965) in *Lilium longiflorum* reported an increase in the number of flowers with the application of CCC. Increased flower number and size in *Hippeastrum* with GA_3, IAA and CCC was also observed by Bose *et al.*, (1980).

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