Plant Growth Regulators Affect the Development of Both Corms and Cormels in *Gladiolus*

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Abstract. The effects of BA, ethephon, and GA₃ on freshly harvested cormels of three cultivars of *Gladiolus* sp. were studied for 3 years. The treatment with 400 mg·L⁻¹ ethephon significantly reduced the dormancy period by 17.5 days as compared to control, while BA and GA₃ were found to be less effective. Among all treatments, ethephon at 400 mg·L⁻¹ was found to be the most effective in altering the days to sprout, sprouting percentage, corm size and production and development of cormels. While GA₃ at 100 mg·L⁻¹ increased growth of corms and cormels, BA at 25 mg·L⁻¹ increased growth of corms and cormels. BA at 25 mg·L⁻¹ only influenced the sprouting percentage of cormels. Along with reducing the dormancy period, the plant growth regulators stimulated growth and development of corms and cormels. Chemical names used: benzyladenine (BA); 2-chloroethylphosphonic acid (ethephon); gibberellic acid (GA₃).

The effectiveness of chemicals such as gibberellins (Arora et al., 1992), benzyladenine (Goo et al., 1998), ethephon (Suh, 1989) and methyl disulfide (Hosoki and Kubara, 1989) in breaking the dormancy of *gladiolus* (*Gladiolus* × *grandiflora* Hort.) corms and cormels has been studied extensively, treatment efficacy varies with chemical, cultivar, and other factors. Although cormels are more dormant than are corms, (Imanishi, 1981) their responses have not been thoroughly studied. Our objective was to find a suitable treatment to break the dormancy of cormels of three *gladiolus* cultivars and to determine their effects on the development of both corms and cormels.

Materials and Methods

The study was carried out over 3 years under open field conditions at the Floricultural Experimental Farm of the Institute of Himalayan Bioresource Technology, Palampur, situated in the foothills of Himalayas at an altitude of ≈1300 m and having a subtemperate type of climate. Average minimum and maximum monthly temperatures recorded over 3 years were 5.5 °C (January) and 30.4 °C (June), respectively. Average minimum and maximum rainfall occurred in October (27.8 mm) and August (607.6 mm), respectively.

Three plant growth regulators, BA, ethephon, and GA₃ were tested on fresh cormels of 'Friendship', 'Priscilla', and 'Video' within 15 d of harvest. The cormels were obtained by planting corms in June each year. BA was

tested at 25, 50, and 100 mg·L⁻¹, GA₃ at 25, 50, and 100 mg·L⁻¹ and ethephon at 100, 200, and 400 mg·L⁻¹. The cormels (0.75 ± 0.1 cm in diameter and weighing ≈0.45 g) were soaked in the solutions for 24 h (Arora et al., 1992; Hong and Goo, 1991) in the fourth week of January and planted in the field. The experiment was a factorial (plant growth regulator × cultivars) in a randomized complete-block design with three replications of 20 cormels each per replication. Cultural operations were as described by Anderton and Park (1989). Corms and cormels were harvested in October each year. Data (Table 1) were recorded for five cormels and corms in each replication. Days to sprouting was counted as days taken from sowing to the date the shoot emerges out of the soil.

To correct for heterogeneity of variance, data for percentage sprouting were transformed using angular (arc-sine) transformation. All data were analyzed by analysis of variance, and mean separation was accomplished by least significant difference (LSD), $P \leq 0.05$. Interactions between plant growth regulators and cultivars were nonsignificant and hence are not presented.

Results and Discussion

Days to sprouting. All chemicals regardless of concentration, significantly hastened sprouting of the cormels (Table 1), but 400 mg·L⁻¹ ethephon was most effective. BA and GA₃ were less effective than ethephon, as previously reported by Suh (1989).

The breaking of dormancy in *gladiolus* cormels has been linked to ethylene production. Ginzburg (1974) reported that ethephon promoted the growth of dormant cormels, and application of BA induced ethylene production (Ginzburg, 1973). 'Priscilla' cormels sprouted earliest, followed by 'Video' and 'Friendship'.

Percentage of sprouting. Of the 10 treatments, only ethephon at 200 and 400 mg·L⁻¹ and BA at 25 mg·L⁻¹ significantly increased percentage sprouting of cormels with 400 mg·L⁻¹ ethephon being most effective and BA 25 mg·L⁻¹ being least effective. Promotion of sprouting of *gladiolus* cormels by ethephon was also noted by Ginzburg (1973) and other workers. Suh (1989) reported that ethephon (200 mg·L⁻¹) promoted sprouting of 'Red Beauty' cormels while BA (20 mg·L⁻¹) or GA₃ (200 mg·L⁻¹) had little effect. However, Goo et al., (1998) reported promotional effects of BA. Friendship sprouted best followed by 'Priscilla', sprouting of 'Video' was significantly lower.

Corm size. All treatments increased corm size with ethephon being most effective (Table 1). Suh and Kwack (1990) reported that when cormels were soaked in 20 mg·L⁻¹ BA, 200 mg·L⁻¹ GA₃ or 200 mg·L⁻¹ ethephon for 6 h, ethephon was most effective in increasing diameter. 'Friendship' produced significantly largest corms than did 'Priscilla' and 'Video'.

Weight of corms. All chemicals significantly increased corm weight with 200 mg·L⁻¹ ethephon and 400 mg·L⁻¹ ethephon having maximum effect. Hong and Goo (1991) reported that treatment with ethephon for 24 h increased corm weight and quality. Suh and Kwack (1990) observed that exposure to smoke (smoke contains ethylene) increased corm weight. Corm weight varied with cultivar, 'Friendship' producing the largest and 'Video' the smallest corms.

Cormel production. All treatments significantly increased cormel production, with maximum effects of 400 mg·L⁻¹ (138.6% increase) and 200 mg·L⁻¹ ethephon (90.3%). GA₃ was more effective than BA. Halevy et al (1970) reported that ethephon increased cormel production by more than 100% in 'Spic and Span' and Magie (1971) noted a 90% increase following ethephon treatment. Hong and Goo (1991) found 400 mg·L⁻¹ ethephon to be the best treatment for cormel production. Although Bhattacharjee (1984) reported that GA₃ (10 and 100 mg·L⁻¹) increased cormel production in 'Friendship', Arora et al. (1992) reported no significant effect of GA₃ on cormel production. 'Friendship' produced the most cormels and 'Video' the least.

Weight of cormels. All chemicals significantly increased the weight of the cormels, maximum effect being obtained with 400 mg·L⁻¹ ethephon (200%) followed by 200 mg·L⁻¹ ethephon (104.8%). 'Friendship' cormels were significantly heavier than 'Priscilla' and 'Video' cormels.

In conclusion, ethephon at 400 mg·L⁻¹ was most effective treatment for many of the growth parameters including days to sprouting, percentage sprouting, corm diameter and cormel production and weight. Hong and Goo (1991) also noted that the best results were obtained with 400 mg·L⁻¹ ethephon. This effectiveness of ethephon in hastening sprouting may be due to breaking of apical dominance (Halevy et al, 1970), whereas its effects on corm and cormel production may have been due to an increase in assimilate mobilization, as the water poten-

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Table 1. Effects of plant growth regulators on sprouting of cormels and corm and cormel production of three gladiolus cultivars. Average data for 3 years (1995, 1996, and 1997)

	Concn	No. of days	Sprouting	Corm		Cormel	
Treatment	(mg·L ⁻¹)	to sprouting	(%) ^z	Diam (cm)	Wt (g)	No./plant	Wt (g)
Plant growth regulators							
BA	25	75.3 ^y b–d	50.3 (51.7) bc ^x	4.2 a	38.4 a-c	17.4 bc	6.5 c
	50	77.6 d	47.4 (47.0) b–d	4.2 a	34.5 e	16.5 c	6.8 bc
	100	75.7 b–d	44.7 (46.0) d	4.3 a	36.5 bc	17.8 bc	7.3 bc
Ethephon	100	73.0 b	49.1 (48.9) b–d	4.6 a	42.3 ab	19.5 bc	7.8 bc
	200	75.9 b–d	52.1 (53.5) b	4.6 a	43.9 a	21.7 b	8.6 b
	400	67.7 a	57.3 (60.0) a	4.6 a	43.3 a	27.2 a	12.6 a
GA ₃	25	75.5 b–d	50.1 (49.8) bc	4.3 a	36.9 bc	18.2 bc	6.9 bc
	50	74.2 bc	46.6 (44.8) cd	4.3 a	38.2 a–c	19.3 bc	7.5 bc
	100	76.7 cd	48.1 (49.3) b–d	4.4 a	39.4 a–c	20.2 bc	8.4 b
Control		85.2 e	44.7 (45.4) d	3.7 b	27.1 d	11.4 d	4.2 d
Cultivars							
Friendship		80.6 b	57.3 (58.2) a	4.6 a	42.1 a	28.8 a	9.0 a
Priscilla		67.5 a	51.0 (54.7) b	4.2 b	38.2 b	15.4 b	7.2 b
Video		78.9 b	38.9 (36.6) c	4.0 b	33.9 c	12.5 c	6.8 b

^zAnalysis done after arcsin transformation of data.^yMeans separation within columns and treatments (plant growth regulators, cultivar) by LSD_{0.05}.^xNumbers in parentheses are the means for 3 years of nontransformed values.

tial of the corm (the competitive sink) remained high, aiding its growth and assimilate attraction (Robinson, 1983). Achhireddy et al. (1984) reported that the translocation of reserves to the sink in bean explants was promoted by ethephon, GA₃, IAA, and BA. Ganyushkin (1993) also reported that Camposan (a trade formulation of 50% ethephon available in Russia) had a marked effect on tissue metabolism of gladiolus corms, but the extent of its influence on the physiological and biochemical processes depended on the time of treatment and especially on varietal characteristics.

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