Acta Bot. Neerl. 22(6), December 1973, p. 666–674.

ABSCISSION OF FLOWER BUD PEDICELS IN BEGONIA
I. EFFECTS OF PLANT GROWTH REGULATING SUBSTANCES ON THE ABSCISSION WITH INTACT PLANTS AND WITH EXPLANTS

CH. H. HÄNISCH TEN CATE and J. BRUINSMA

Afdeling Plantenfysiologie, Landbouwhogeschool, Wageningen

SUMMARY

Pedicel abscission of flower buds is retarded by the presence of the bud and by IAA, the buds probably preventing abscission by auxin production. Ethylene removes the retarding effect of the buds and also accelerates the abscission of pedicel explants without buds. ABA has a small accelerating effect, gibberellic acid and kinetin are inactive. The presence of vegetative plant parts enhances the abscission rate, mainly by the supply of nutrients. The difference in flower bud abscission between three *Begonia* clones depends on a difference in the pedicels which is probably not hormonal in nature.

1. INTRODUCTION

The abscission process has generally been regarded as a senescence phenomenon. Apart from a few exceptions (VALDOVINOS & JENSEN 1972, YAGER 1959), it has mainly been studied with such adult organs as petioles and fruit stalks (BIGGS 1971, LEOPOLD 1971). By contrast, abscission of flower buds of ornamental *Begonia* cultivars occurs in young pedicels which are still elongating. In order to compare the abscission in this juvenile tissue with the literature data on adult ones, the effects were studied of different growth regulating substances applied to flower bud pedicels which were either attached to the plant or excised, and which bore a flower bud or had their buds cut off.

2. MATERIALS AND METHODS

The abscission was studied in three clones selected from the cross (*Begonia cinnabarina* Hook. × *B. micranthera* Griessl) × *B. davisii* Veitch. These clones look very similar but differ in their tendency to bud drop. The flowers, arranged in a dichasium, are male, old plants rarely carrying some female flowers. The abscission occurs just above the branchings (*fig. 1*). The clones were grown in a greenhouse at 18°C minimum temperature and 18 hrs. light per day. From October until March extra illumination was supplied from high pressure mercury lamps (Philips HPR-400W) and incandescent lamps.

With *intact plants*, growth regulators were applied either by injecting 2 µl solutions into the pedicels or by placing 4 µl drops on the bracts (*fig. 1*). The

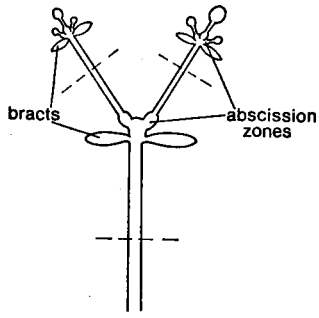

Fig. 1. Diagram of part of an inflorescence. The broken lines indicate the proportion of the explants.

latter application was repeated twice a week during four weeks and the abscission determined every other day, using three plants per treatment.

Explants were cut from the penultimate branchings with distal ends of 0.5–2 cm and proximal ends of 1.5 cm (*fig. 1*). The explants were placed through holes in plexiglass holders in Petri dishes, 20 cm diameter, 50 explants per dish, with their proximal ends generally in 250 ml of tap water, sometimes in solutions for proximal applications. Distal application of growth regulators to explants carrying buds ('*bud explants*') occurred by injection of 2 µl solution underneath the buds, to explants without buds ('*pedicel explants*') by placing 2 µl solution on the cut surface. Ethylene was applied either as Ethephon or as a gas in experiments using desiccators sealed with a rubber cap, through which known amounts of water saturated with ethylene were injected; the ethylene concentration was measured with a Varian 1800 gas chromatograph.

The incubation of the explants was at 18 °C in the dark, unless indicated otherwise. The abscission was determined at different points of time after gently touching the pedicels with a pair of tweezers. The interpolated time at which 50% of the pedicels had abscised (T_{50}) was used as a measure for the rate of abscission. The effect of growth regulators was indicated by expressing their T_{50}-values in per cents of those of the water-treated controls, values above and below 100% representing retardation and acceleration of abscission, respectively. Bacterial contamination was never observed.

3. RESULTS

3.1. Effects of growth regulators on flower(bud) abscission

The effects of indoleacetic acid (IAA), abscisic acid (ABA), and the ethylene-releasing substance Ethephon, when applied to the bracts of pedicels with plants in the greenhouse, are shown in *table 1*. The three clones produced about the same amounts of flowers, but in the clones 2 and 3 a higher percentage abscised in the bud stage already. IAA prevented the abscission of flowers, particularly in clones 2 and 3, often only the petals abscised. ABA had little effect, but Ethephon considerably increased the total drop of flowers, particu-

Table 1. Effects of 4 µl regulator solution, applied twice a week to the bracts, on abscission of buds and flowers of intact plants, three plants per treatment.

	total drop of buds and flowers in 4 weeks			percentage abscised as buds		
clone	1	2	3	1	2	3
H_2O	440	397	424	6	22	21
5.10^{-3}M IAA	443	238	276	9	21	30
5.10^{-4}M ABA	459	340	443	8	35	22
10^{-3}M Ethephon	529	597	663	24	67	60
LSD (P = 0.05)		55			15	

larly by enhancing abscission in the bud stage.

Injection of IAA into the pedicels strongly retarded abscission, ABA was ineffective, and Ethephon highly accelerated the abscission of buds: *fig. 2.*

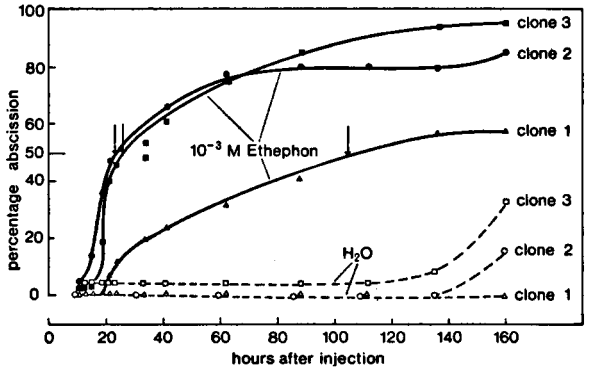

Fig. 2. Effect of a single injection of 2 µl 10^{-3}M Ethephon solution underneath the buds on the abscission of pedicels of intact plants. Arrows indicate T_{50}-values.

3.2. Effect of the flower buds on pedicel abscission

Experiments with explants with and without buds ('bud explants' and 'pedicel explants', respectively) were performed in order to analyse the influence of the flower buds on the rate of abscission of the pedicel (*table 2*). The flower buds strongly retarded pedicel abscission: whereas the T_{50}-values of pedicel explants were always under 15 hrs., those of the bud explants invariably surpassed 80 hrs. This was mainly due to the presence of the flower buds, soon after the abscission of the flower buds the pedicel also abscised. The pedicels of both the bud explants and the pedicel explants of clones 2 and 3 abscised significantly earlier than those of clone 1.

The effects of IAA, ABA, and ethylene on the abscission of pedicels of bud and pedicel explants are presented in *fig. 3* in relative T_{50}-values, those of the controls being 100%. The abscission-retarding effect of IAA is always consider-

Table 2. Abscission of buds and pedicels of explants. Numbers followed by different indices differ significantly at P = 0.05.

	Hours until 50% abscission (T_{50})		
clone	1	2	3
Bud explants			
buds	106a	80b	82b
pedicels	116a	85b	86b
Pedicel explants			
pedicels	14.4c	13.6d	13.2d

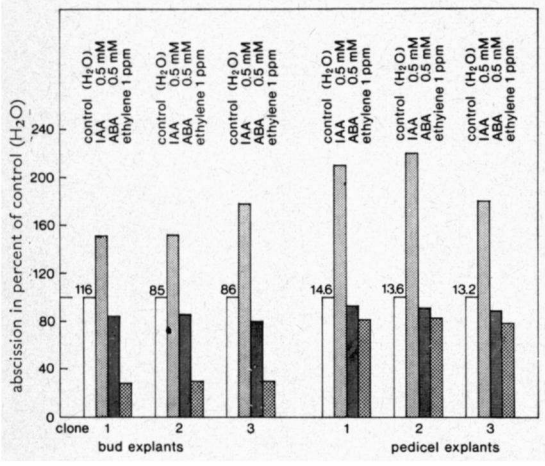

Fig. 3. Relative effects of 2 µl 5.10^{-4}M IAA, 2 µl 5.10^{-4}M ABA, and 1 ppm ethylene, on pedicel abscission of pedicel and bud explants. The T_{50}-values of the controls, in hours, are indicated above the bars.

able, although varying from one experiment to the other. ABA has a small, ethylene a larger accelerating effect, particularly with the bud explants because it induces the buds to abscise rapidly (cf. *fig. 2*).

3.3. Effect of the plant on pedicel abscission

Figures 4, 5 and *6* show the rates of abscission of pedicels with their buds cut off, either being still attached to the plant or as pedicel explants. The experiments were performed in the greenhouse, the Petri dishes with the explants being kept under the same conditions as the plants. To the distal ends of the pedicels 2 µl water or regulator solution were applied. Again, IAA retarded and ABA and Ethephon promoted abscission, and their relative effects are the same for the three clones, irrespective whether the pedicels are attached or detached (*table 3*).

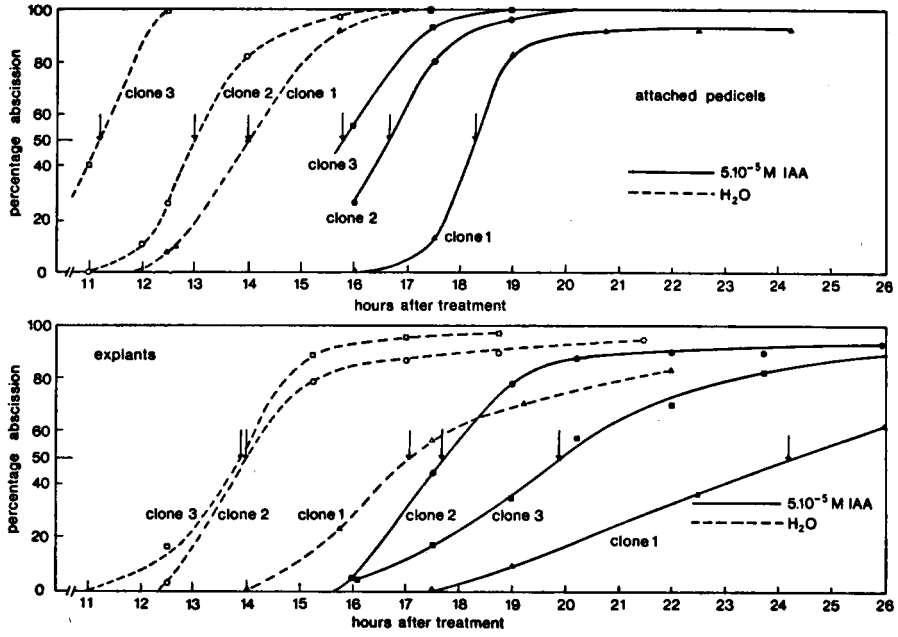

Fig. 4. Effects of 2 µl 5.10^{-5}M IAA at the cut surface of disbudded pedicels, either attached to the plants or excised. Arrows indicate T_{50}-values.

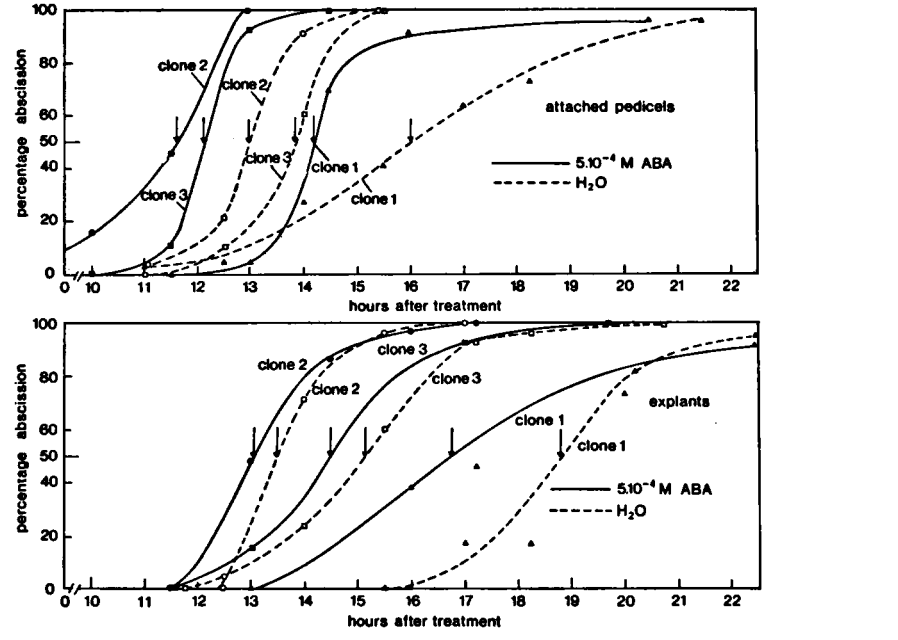

Fig. 5. Effects of 2 µl 5.10^{-4}M ABA at the cut surface of disbudded pedicels, either attached to the plants or excised. Arrows indicate T_{50}-values.

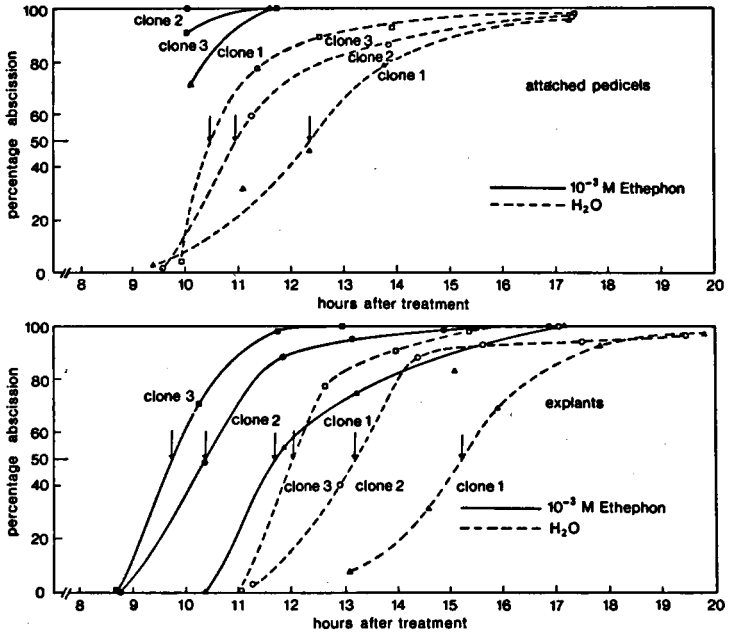

Fig. 6. Effect of 2 µl 10^{-3}M Ethephon at the cut surface of disbudded pedicels, either attached to the plants or excised. Arrows indicate T_{50}-values.

Table 3. Effects of IAA, ABA, and Ethephon on the abscission of pedicels without flower buds.

clone		T_{50}-values, in % of control (H_2O)		
		1	2	3
pedicels attached	IAA	136	131	143
	ABA	86	91	90
	Ethephon	–	–	–
pedicels excised	IAA	131	135	133
	ABA	89	93	93
	Ethephon	77	79	80

In all experiments the abscission of attached pedicels proceeds significantly more rapidly than that of excised pedicels, indicating an abscission-stimulating factor being provided by the plant (*figs. 4, 5* and *6*).

Experiments with pedicel explants placed with their proximal ends in glucose solutions or in water, indicate that the supply of assimilates accelerates the energy-requiring abscission process (*table 4*). Comparison with attached pedicels shows that this nutrient supply accounts for the larger part of the effect of the presence of the plant.

Table 4. Abscission of pedicels without buds, either attached to the plant or excised, standing in water or in a 1 mM glucose solution.

	T_{50}-values, in per cents of control		
clone	1	2	3
attached pedicels	91 ± 1	90 ± 1	92 ± 2
excised pedicels			
in 1 mM glucose	93 ± 4	93 ± 4	94 ± 3
in water	100	100	100

3.4. Effects of different growth regulators on pedicel abscission

The preceding experiments show that the presence of the flower buds and of the plant do not affect the sensitivity of the pedicel to growth regulators, except that ethylene is far more active in the presence of buds. This allows to determine the effects of different growth regulators on pedicel abscission using pedicel explants.

Fig. 7 shows the concentration ranges within which IAA, ABA, and ethylene affect the abscission process, the three clones being equally sensitive to these substances. Gibberellins and cytokinins fail to influence abscission, as shown in *fig. 8* for gibberellin GA_3 and for kinetin. It made no significant difference whether the growth regulators were applied in a drop to the distal end or in the solution in which the proximal ends were immersed.

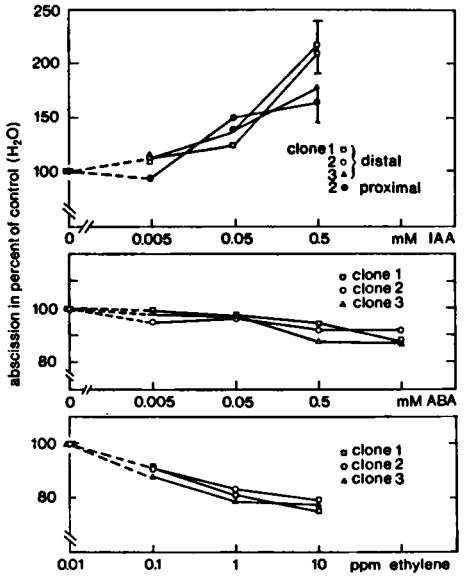

Fig. 7. Relative effects of IAA, ABA, and ethylene on the rate of abscission of pedicel explants. IAA and ABA were distally applied in 2 µl drops and, if indicated, proximally in the solution in the Petri dish.

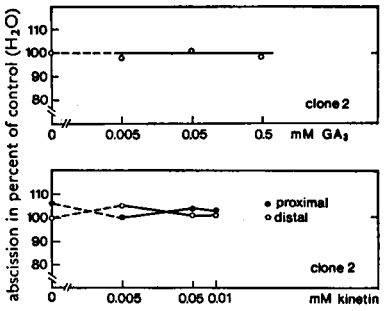

Fig. 8. Absence of effect of gibberellic acid and of kinetin on the abscission of pedicel explants.

4. DISCUSSION

The effects of growth regulating substances on the abscission of young, still elongating pedicels of flower buds of *Begonia* differ in some aspects from those found in studies with adult petioles and fruit stalks (BIGGS 1971, LEOPOLD 1971). Contrary to some observations with petioles (BÖTTGER 1970, CHATTERJEE & LEOPOLD 1964), gibberellin and cytokinin do not affect the abscission of pedicels. The only small effect of ABA can be ascribed to the juvenility of the pedicels (SMITH et al. 1968, ZUCCOMI et al. 1969).

As with adult organs, IAA invariably delays abscission. The strong retarding effect of the presence of buds or flowers on the abscission of the pedicel points to a prevention of abscission by auxin produced by these organs. It is generally agreed that the auxin production of an organ is the main abscission-preventing factor (JACOBS 1968). In flowers of *Nicotiana tabacum*, YAGER (1959) found that removal of ovaries enhanced abscission; indoleacetic acid retarded the abscission, also in intact flowers. In the present study only male flowers were used; their auxin production is discussed by HÄNISCH TEN CATE, BERGHOEF, VAN DER HOORN & BRUINSMA (in preparation). That application of IAA to the distal end of disbudded pedicels could not delay abscission to the same extent as the flower bud did, is due to the difference between a single application and continuous production of the auxin.

Ethylene strongly accelerates abscission, particularly when flowers or buds are present. This growth regulator largely removes the retarding effect of flower and bud. Ethylene is known to decrease the synthesis and transport of IAA and to increase IAA destruction (BURG 1968). The sensitivity to ethylene of intact systems has sometimes been demonstrated with leaves, too (MORGAN 1969). However, ethylene does not act by removing the effect of the flower buds only, because also the abscission rate of pedicel explants without buds is enhanced by this hormone. Similar effects of ethylene were found with petiole explants (ABELES et al. 1971).

The accelerating effect of the presence of the vegetative plant is largely due to the supply of assimilates. Because glucose is able to replace the plant, there is no indication that next to this nutritive factor also a hormonal factor is

involved, e.g. a specific 'senescence factor' (OSBORNE et al. 1972).

The difference in tendency to bud drop of the three clones is reflected in the difference in abscission rate of the pedicels, either attached or excised, irrespective whether flower buds are present or not. The difference can, therefore, be located in the pedicel itself. It is probably not hormonal in nature because the relative sensitivity of the three clones to the various growth-regulating substances was remarkably similar. The anatomical features of the abscising pedicels are described elsewhere (HÄNISCH TEN CATE et al. 1973).

ACKNOWLEDGEMENTS

The three *Begonia* cultivars were kindly supplied by the Director of the Department of Horticulture of the Agricultural University at Wageningen, Prof. Dr. J. Doorenbos. The co-operation of Mrs. C. Tjallingii-Moll, Miss J. van Houdt, and Mr. K. Boeve is gratefully acknowledged.

REFERENCES

ABELES, F. B., L. E. CRAKER & G. L. LEATHER (1971): Abscission: The phytogerontological effects of ethylene. *Plant Physiol.* **47**: 7–9.

BIGGS, R. H. (1971): Citrus abscission. *Hort. Sci.* **6**: 388–392.

BÖTTGER, M. (1970): Die hormonale Regulation des Blattfalls bei Coleus rehneltianus Berger. I. Die Wechselwirkung von Indol-3-Essigsäure, Gibberellin- und Abscisinsäure auf Explantate. *Planta* **93**: 190–204.

BURG, S. P. (1968): Ethylene, plant senescence and abscission. *Plant Physiol.* **43**: 1503–1511.

CHATTERJEE, S. K. & A. C. LEOPOLD (1964): Kinetin and gibberellin actions on abscission processes. *Plant Physiol.* **39**: 334–337.

HÄNISCH TEN CATE, CH. H., J. J. L. VAN DER PLOEG-VOOGD & J. BRUINSMA (1973): Abscission of flower bud pedicels in *Begonia*. III. Anatomical pattern of abscission. *Acta Bot. Neerl.* **22**: 681–685.

JACOBS, W. P. (1968): Hormonal regulation of leaf abscission. *Plant Physiol.* **43**: 1480–1495.

LEOPOLD, A. C. (1971): Physiological processes involved in abscission. *Hort. Sci.* **6**: 376–378.

MORGAN, P. W. (1969): Stimulation of ethylene evolution and abscission in cotton by 2-chloroethane phosphonic acid. *Plant Physiol.* **44**: 337–341.

OSBORNE, D. J., M. B. JACKSON & B. V. MILLBORROW (1972): Physiological properties of abscission accelerator from senescent leaves. *Nature N.B.* **240**: 98–101.

SMITH, O. E., J. L. LYON, F. T. ADDICOTT & R. E. JOHNSON (1968): Abscission physiology of abscisic acid. *Biochem. Physiol. Plant Growth Subst.* Ottawa: **1**.

VALDOVINOS, J. G. & T. E. JENSEN (1972): Abscission: the effects of actinomycin D and cycloheximide on the ultrastructure of abscission cells of Nicotiana tabacum. *Amer. J. Bot.* **59**: 671 (abstracts).

YAGER, R. E. (1959): Some effects of leaves and indoleacetic acid upon floral abscission in Nicotiana tabacum. *Bot. Gaz.* **121**: 244–249.

ZUCCOMI, F., R. STÖSSER & M. J. BUKOVAC (1969). Promotion of fruit abscission with abscisic acid. *Bio. Sci.* **19**: 815–817.