Note

Effects of AgNO₃ and Ethylene Biosynthetic Inhibitors on Auxin-induced Petiole Epinasty of *Morus alba*

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Epinastic bending of the petioles in many dicots occurs when elongation in the adaxial (upper) side is more rapid than that in the abaxial (lower) side.^{1–3} Ethylene involvement in auxin-induced epinasty was shown by Amrhein and Schneebeck,⁴ who reported that naphthaleneacetic acid (NAA)-induced epinasty of tomatoes was accompanied by increased ethylene production and that application of aminoxyacetic acid (AOA) with NAA inhibited ethylene production and prevented epinasty. Reduction of epinasty and ethylene production also occurred in mechanically stressed poinsettias that were treated with AOA or aminoethoxyvinylglycine (AVG).⁵ In contrast, petiole epinasty in chrysanthemums⁶ and epinasty of tomato leaf midribs⁷ can also be induced by auxin when ethylene synthesis is prevented. This paper describes a study on petiole epinasty induced by indole-3-acetic acid (IAA) or Ethephon (2-chloroethylphosphonic acid), an ethylene-releasing compound, in leaves of field-grown mulberry (*Morus alba* L. cv. Ichinose) and of detached shoots.

The third, or fourth leaf (counted from the top) of coppice shoots at the 11- to 18-leaf stage (in late May and early and middle June) from low-pruned stumps of mulberry,⁸ grown in a light clay soil at the Saga Experimental Farm of Kyoto Inst. of Technology, Kyoto, Japan, was used and applications of test compounds were done between 9:00–10:30 a.m. In the first experiment, individual whole surfaces of petioles were painted with IAA (Wako Pure Chemical Ind., Ltd., Osaka, Japan) or Ethephon (Nissan Chemical Co., Ltd., Tokyo, Japan) in aqueous solution (pH adjusted to 5.5), using absorbent cotton. In the second experiment, the test compound was applied to either the adaxial or abaxial surfaces of petioles, using absorbent cotton. In the third experiment, individual leaf petioles were treated with aqueous solutions containing IAA or Ethephon and/or AVG (Fluka Chemie AG, Buchs, Switzerland), AOA, CoCl₂, or AgNO₃ (Wako Pure

Chemical Ind., Ltd., Osaka, Japan) (pH adjusted to 5.5; Table II), using absorbent cotton. Leaf angle was measured with a transparent protractor as the angle between the stem and the adaxial surface of the petiole.^{9,10}

A basal-feeding system was used to overcome problems of petiolar penetration and subsequent translocation of the test compounds. Coppice shoots at the 11- to 18-leaf stage were collected and the leaves below the developed fifth leaf entirely removed. The basal end of the shoot (length about 12 cm below the node of the fourth leaf) was cut again and washed when introducing the shoots into test solutions, and groups of 3 shoots were introduced basally into 100-ml 11-cm high Erlenmeyer flasks, containing 80 ml test solution. These procedures were completed by 10:30 a.m., and then the shoots were kept for 24 hr in a laboratory at room temperature under natural daylength. Curvature of the fourth leaf of the shoot was measured with a transparent protractor as described above.

Fig. 1. Response of Petioles of Field-grown Mulberry to IAA or Ethephon Applied to the Petioles.

Short- (a) and long-term measurements (b). IAA or Ethephon: 100 ppm (●), 50 ppm (○), 10 ppm (▲), 1 ppm (△), and 0 ppm (H₂O) (■). Values are means for 3 replications with 5 plants each.

Table I. DIFFERENTIAL RESPONSE 6 hr AFTER PARTIAL APPLICATION OF 50 ppm IAA OR 100 ppm ETHEPHON TO THE PETIOLES OF MULBERRY (Means ± S.E. of 3 Replications of 5 Plants Each)

Growth regulator/treated region	Epinasty (degrees)
IAA/adaxial	18 ± 5
IAA/abaxial	5 ± 2
Ethephon/adaxial	8 ± 3
Ethephon/abaxial	2 ± 1

Table II. EFFECTS OF AgNO_3 AND ETHYLENE BIOSYNTHETIC INHIBITORS ON IAA- OR ETHEPHON-INDUCED PETIOLE EPINASTY IN MULBERRY (Means $\pm$ S.E. of 3 Replications of 5 Plants Each)

Inhibitor (ppm)		Epinasty (degrees) 5 hr after treatment		
		H_2O	10 ppm IAA	100 ppm Ethephon
No inhibitor (H_2O)		2 $\pm$ 1	13 $\pm$ 5	10 $\pm$ 4
AVG	50	2 $\pm$ 1	13 $\pm$ 6	n.d.
	100	2 $\pm$ 1	12 $\pm$ 6	n.d.
	500	1 $\pm$ 1	12 $\pm$ 5	10 $\pm$ 5
AOA	50	2 $\pm$ 1	13 $\pm$ 5	n.d.
	100	2 $\pm$ 1	12 $\pm$ 5	n.d.
	500	2 $\pm$ 1	12 $\pm$ 5	11 $\pm$ 5
CoCl_2	50	2 $\pm$ 1	13 $\pm$ 6	n.d.
	100	2 $\pm$ 1	13 $\pm$ 6	n.d.
	500	1 $\pm$ 1	14 $\pm$ 5	11 $\pm$ 6
AgNO_3	50	2 $\pm$ 1	10 $\pm$ 4	7 $\pm$ 3
	100	1 $\pm$ 1	5 $\pm$ 2	5 $\pm$ 2
	500	1 $\pm$ 1	3 $\pm$ 2	3 $\pm$ 2

n.d. = not determined.

Applications of IAA or Ethephon in aqueous solution to the petioles had a profound effect on the leaf angle (Fig. 1). The petioles showed a much greater curvature response to 50 ppm IAA or 100 ppm Ethephon when they were applied to the adaxial side of the petioles rather than to the abaxial side (Table I), which corroborates earlier findings of differential sensitivity between the tissues of the two halves of the petioles in *Helianthus annuus* and other species.^{2,3)} The ethylene action inhibitor AgNO_3 ^{11,12)} inhibited IAA- and Ethephon-induced epinasty in mulberry petioles effectively, but the ethylene biosynthetic inhibitors AVG, AOA, and CoCl_2 ^{4-6,9,13-15)} had little effect (Table II). The results obtained for epinastic curvature of petioles in detached shoots fed IAA (1–50 ppm) via the cut bases for 24 hr are similar to those in field-grown plants treated with IAA (data not shown). Further AVG, AOA and CoCl_2 had little or no influence on IAA- and Ethephon-induced petiole epinasty in

detached shoots when the inhibitor (up to 100 ppm) and 10 ppm solutions of IAA or Ethephon were applied to the shoots (data not shown).

These data (Fig. 1, Tables I and II), together with our previous work,¹⁶⁾ agree with other reports on this and other species,¹⁻³⁾ except that the ethylene biosynthetic inhibitors AVG, AOA, and CoCl_2 ^{4,5,9,13-15)} had little effect on IAA-induced epinasty in mulberry petioles (Table II).

References

- 1) F. B. Abeles, "Ethylene in Plant Biology," Academic Press, New York, 1973, pp. 103–152.
- 2) B. G. Kang, in "Encyclopedia of Plant Physiology, New Ser.," Vol. 7, ed. by W. Haupt and M. E. Feinleib, Springer-Verlag, Berlin, 1979, pp. 647–667.
- 3) J. H. Palmer, in "Encyclopedia of Plant Physiology, New Ser.," Vol. 11, ed. by R. P. Pharos and D. M. Reid, Springer-Verlag, Berlin, 1985, pp. 139–168.
- 4) N. Amrhein and D. Schneebeck, *Physiol. Plant.*, **49**, 62 (1980).
- 5) M. E. Saltveit and R. A. Larson, *J. Am. Soc. Hort. Sci.*, **108**, 253 (1983).
- 6) S. C. Furutani, W. S. Sakai, T. Hata and M. A. Nagao, *HortSci.*, **22**, 100 (1987).
- 7) S. Kazemi and N. P. Kefford, *Plant Physiol.*, **54**, 512 (1974).
- 8) T. Suzuki, M. Kitano and K. Kohno, *Tree Physiol.*, **4**, 53 (1988).
- 9) C. D. Schlagnhauser and R. N. Artica, *Physiol. Plant.*, **65**, 151 (1985).
- 10) K. J. Bradford and S. F. Yang, *Plant Physiol.*, **65**, 322 (1980).
- 11) E. M. Beyer, Jr., *Plant Physiol.*, **58**, 268 (1976).
- 12) H. Veen, *Scientia Hort.*, **20**, 211 (1983).
- 13) K. J. Bradford, T. C. Hsiao and S. F. Yang, *Plant Physiol.*, **70**, 1503 (1982).
- 14) C. D. Schlagnhauser and R. N. Artica, *Plant Physiol.*, **78**, 300 (1985).
- 15) V. M. Ursin and K. J. Bradford, *Plant Physiol.*, **90**, 1341 (1989).
- 16) T. Suzuki, *Nippon Sanshigaku Zasshi*, **55**, 494 (1986).