

Lettuce Seed Germination: Interaction between Auxin and 2-Chloroethanephosphonic acid (Ethrel)

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Abstract. Auxins (NAA, IAA) inhibited the seed germination of lettuce cv. Cabbage. The auxin-induced inhibition of seed germination could be overcome if 2-chloroethanephosphonic acid (CEPA, ethrel) or kinetin was added simultaneously. Thus ethylene can also modulate the action of endogenous inhibitors in seed germination.

Ethrel (2-chloroethanephosphonic acid) causes effects similar to ethylene, and apparently breaks down in plant tissues releasing ethylene to a site of action (Ethrel — Technical Data Sheet 1969, PRATT and GOESCHL 1969). Ethylene is now well-known as an endogenous bio-regulant which actively affects almost all phases of plant growth and development including seed germination (PRATT and GOESCHL 1969, ABELES and LONSKI 1969). Like kinetin (EVENARI 1965), ethylene also promotes lettuce seed germination (ABELES and LONSKI 1969, D. SANKHLA and N. SANKHLA 1972). On the other hand, auxin has been shown to be a potent inhibitor of seed germination in several strains of lettuce (EVENARI and MAYER 1954, KHAN and TOLBERT 1966, D. SANKHLA and N. SANKHLA 1968).

Since ethrel mimics ethylene action and is known to stimulate strongly seed germination in lettuce cv. Cabbage (D. SANKHLA and N. SANKHLA 1972) and since ethylene and auxins are interrelated in their action (MORGAN and GAUSMAN 1966), it was deemed of interest to carry out experiments on ethylene-auxin interaction. The results of this investigation are presented hereunder.

Methods

The seeds of *Lactuca sativa* cv. Cabbage served as experimental material. They were allowed to germinate at about 30 °C on a single layer of filter paper in 9 cm petri-dishes (100 seeds each) moistened with 5 ml of the test solution. During the experimental period, the seeds received illumination from three fluorescent lamps (Philips, 40 W) hanging at a distance of about a metre. Ethrel (2-chloroethanephosphonic acid, ACP-68-250) containing propylene glycol as a carrier base was obtained as a gift from M/s Agromore (India) Ltd.

Abbreviations used: CEPA, 2-chloroethanephosphonic acid; IAA, indole-3-acetic acid; NAA, phthalene-acetic acid; K, kinetin.

Results and Discussion

As observed earlier for lettuce cv. Attraktion and Hohlbätteriger Butter (D. SANKHLA and N. SANKHLA 1968) as well as lettuce cv. Grand Rapids (EVENARI and MAYER 1954, KHAN and TOLBERT 1966), auxin proved to be a potent inhibitor of seed germination for lettuce cv. Cabbage (Table 1). In the present investigation both NAA as well as IAA retarded germination if used at a concentration higher than 10 ppm. This was accompanied by a simultaneous decrease in root and hypocotyl elongation. The results further indicate that both kinetin and CEPA greatly stimulated the rate of germination as well as its final percentage in this lettuce variety. In other strains of lettuce too, the two growth regulators *viz.*, ethylene and kinetin act as strong stimulators of seed germination. Furthermore, kinetin can also effectively undo the inhibition of seed germination caused by several naturally occurring as well as synthetic growth inhibitors (KHAN and TOLBERT 1966, N. SANKHLA and D. SANKHLA 1967, 1968a, b, KNYPL 1967). In the present investigation, it has been observed that not only kinetin but CEPA as well is able to reverse the inhibition of seed germination caused by auxin (Table 2). Our other results have indicated that CEPA (ethylene) can also negate the inhibition of seed germination caused by abscisic acid (D. SANKHLA and N. SANKHLA 1972).

TABLE 1

EFFECT OF AUXINS, KINETIN AND ETHREL on germination and seedling growth of lettuce cv. "Cabbage"

Concentration [ppm]	Percentage germination after					*Seedling growth after 4 days [mm]	
	24 h	36 h	48 h	60 h	72 h	Root	Hypocotyl
Control	7 ± 3	20 ± 2	35 ± 4	42 ± 5	52 ± 4	25	14
IAA 10	—	—	25 ± 3	30 ± 2	30 ± 2	2	1
IAA 50	—	—	—	15 ± 2	18 ± 2	2	0.5
NAA 10	—	—	2 ± 1	18 ± 2	28 ± 2	1	—
NAA 50	—	—	—	4 ± 2	11 ± 3	0.5	—
CEPA 60	17 ± 3	46 ± 4	62 ± 4	64 ± 4	72 ± 4	18	8
CEPA 120	25 ± 2	51 ± 3	80 ± 2	82 ± 5	92 ± 4	13	10
CEPA 240	19 ± 3	39 ± 3	53 ± 5	57 ± 3	64 ± 4	12	8
K 1	16 ± 4	49 ± 2	58 ± 5	79 ± 3	85 ± 3	29	12
K 10	17 ± 2	60 ± 2	68 ± 2	92 ± 4	95 ± 3	25	12

* Average of ten seedlings.

The mechanism of the action of ethylene in seed germination is not fully known. According to ABELES and LONSKI (1969), the action of ethylene is limited only to the initial steps in the seed germination. Since ethylene is known to affect enzyme secretion (JONES 1967) as well as cell enlargement and differentiation (PRATT and GOESCHL 1969) — processes vital for germination to occur, it might possibly affect germination by initiating any one or more of these physiological processes. The very fact that CEPA can negate

TABLE 2

REVERSAL OF AUXIN-INDUCED INHIBITION of seed germination by ethrel and kinetin

Concentration [ppm]	* Percentage germination after					Seedling growth after 4 days [mm]	
	24 h	36 h	48 h	60 h	72 h	Root	Hypocotyl
IAA 10 + + CEPA 60	—	23 ± 2	56 ± 4	61 ± 5	66 ± 5	8	2
IAA 10 + + CEPA 120	—	11 ± 5	52 ± 4	69 ± 2	75 ± 3	4	1
NAA 50 + + CEPA 120	1	10 ± 2	30 ± 4	46 ± 4	61 ± 4	1	1
IAA 10 + K 1	3 ± 1	37 ± 3	45 ± 5	58 ± 5	59 ± 4	22	10
NAA 50 + K 10	13 ± 2	56 ± 4	66 ± 4	72 ± 3	74 ± 4	1	1

* Percentage germination in control as in Table 1.

the inhibition of seed germination caused by both auxin as well as abscisic acid (D. SANKHLA and N. SANKHLA 1972) would indicate that this antagonism is not a specific one. More experiments are necessary to elucidate the exact nature of the mechanism involved. However, this is a further example supporting the contention that plant growth and development is a function of the endogenous levels of bio-regulants and their interactions.

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Auxiny (NAA, IAA) inhibovaly klíčení semen salátu cv. Cabbage. Inhibice klíčení semen indukovaná auxiny může být anulována současnou aplikací 2-chlorethanfosfonové kyseliny (CEPA, ethrel) nebo kinetinu. Ethylen tak může též pozměnit působení endogenních inhibitorů při klíčení semen.