RADIOBIOLOGY

Aminothioamides as Protectors against the Effect of Gamma-rays in *Allium cepa*

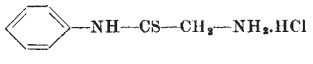
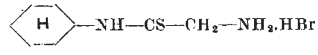
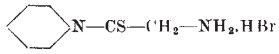
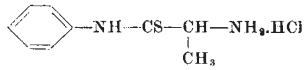
Several aminothioamides of the general type R_1—NH—CS—CH(NH_2)—R_2 have been synthesized[1]. As is generally known with thioamides, these aminothioamides can exist in solution in two tautomeric forms:

$$R_1—NH—CS—CH(NH_2)—R_2 \rightleftharpoons R_1—N=C(SH)—CH(NH_2)—R_2$$

Notably in their thiol form they exhibit a free sulphydryl group as well as a free amino-group separated by two carbon atoms. Such arrangement was shown to favour protection against ionizing radiation[2–4].

The protective potentialities of a number of aminothioamides (Table 1) were tested against the action of gamma-rays from a cobalt-60 source. *Allium cepa* seeds, variety 'White May', were germinated and seedlings with primary roots reaching 3–5 mm were selected and pre-treated for 1 h with a non-toxic concentration of the chemical under investigation. Then together with the respective solution the seedlings were irradiated.

Table 1. Aminothioamides Tested

	Chemical name	Formula
(1)	Amino-thioacetamide hydrobromide	$H_2N—CS—CH_2—NH_2.HBr$
(2)	*N*-Ethyl-amino-thioacetamide hydrobromide	$C_2H_5—NH—CS—CH_2—NH_2.HBr$
(3)	Amino-thioacetanilide hydrochloride	
(4)	*N*-*cyclo*hexyl-aminothio-acetamide hydrobromide	
(5)*	Amino-thioacetpiperidide hydrobromide	
(6)	*N*-Ethyl-D,L-α-aminothiopro-pionamide hydrobromide	$C_2H_5—NH—CS—CH(CH_3)—NH_2.HBr$
(7)	D,L-α-aminothiopropion-anilide hydrochloride	
(8)	*N*-Ethyl-D,L-α-aminothiobutyr-amide hydrobromide	$C_2H_5—NH—CS—CH(C_2H_5)—NH_2.HBr$

* This compound, in solution, does not exist in tautomeric forms.

The protective activity was assessed from: (*a*) the rate of growth of *Allium* roots which received a dose of 350 r. delivered as 5 r./sec; (*b*) from reduction in chromosome aberration at the same dose-level; (*c*) from the survival of roots against a lethal dose. In this communication, results obtained from the rate of growth are given (Fig. 1). Seedlings which were pre-treated with the chemical and then irradiated were thoroughly washed, transferred to Petri dishes containing moistened filter papers and then kept at 26° ± 1° C in a thermostat into which daylight was allowed through a glass door. The rate of growth of the primary roots was measured every 24 h. Measurements were carried out until the ninth day after irradiation, the day in which the normal non-irradiated control generally ceased to grow. Such short experimental duration enabled us to repeat and reproduce our results several times. Protective factors were derived from the rate of growth of irradiated roots pre-treated with one of those chemicals to that of roots irradiated in tap water, that is, irradiated control. This ratio was taken at a time when the normal non-irradiated control showed a maximum rate of growth.

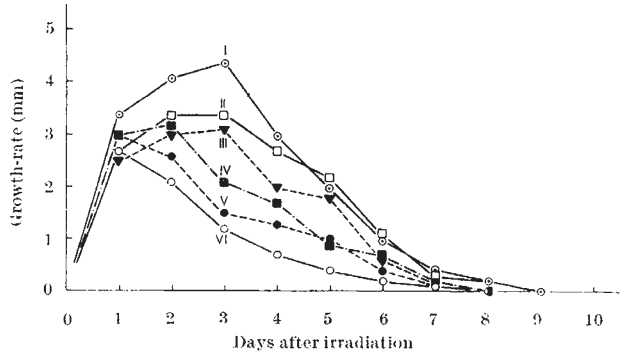


Fig. 1. Rate of growth of *Allium cepa* primary roots after different treatments. I, Normal, non-irradiated control; II, irradiated under anoxic conditions. Pretreated with and irradiated in cysteine (III), aminothioacetamide hydrobromide (IV) and *N*-ethyl-aminoacetamide hydrobromide (V). VI, irradiated control

Among the eight compounds thus screened, two were found to offer some protection, the others being ineffective. Amino-thioacetamide hydrobromide was effective at 1×10^{-2} M concentration with the result that a protective factor of 1·7 was obtained, while *N*-ethyl-aminothioacetamide hydrobromide at an optimum concentration of 5×10^{-3} M gave a factor of 1·25.

In comparison, roots pre-treated with a 5×10^{-2} M cysteine solution for 1 h and then irradiated in the same solution showed a protective factor 2·3, while roots irradiated in tap water deoxygenated by bubbling nitrogen for 45 min before irradiation (anoxic condition) showed a factor of 2·8.

Our results have thus shown that amino-thioamides, in which R = H or C_2H_5, were protective in *Allium*, though the degree of protection was lower than that shown by cysteine. The rest of the compounds having other substitutions were thoroughly ineffective.

It is of interest to note that thioacetamide was recently reported[5] as protecting *Allium cepa* cells against the action of alpha-rays and thermal neutrons, though the effect was limited in time.

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Trophic Level Effect on the Accumulation of Cæsium-137 in Cougars feeding on Mule Deer

In aquatic ecosystems, cæsium-137 levels in predators exceed those of herbivores under conditions of equal contamination of the environment[1–3]. Examples of the step-wise increase in contamination-levels of cæsium-137 in four species of fish representing three trophic levels, and an explanation of the reason for the increase, will be published soon[4]. To our knowledge, no example of trophic level increase has been demonstrated in terrestrial wildlife, although an approximate 2- to 3-fold increase in cæsium-137 in man over his integrated food has been reported by several workers[5–7], and similar results were obtained by feeding cæsium-137 to animals[8,9].