Increased tuberization in potatoes by ethrel (2-chloro-ethyl-phosphonic acid)

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Summary

Doses between 25 and 500 ppm. of ethrel strikingly increased the initiation of potato tubers when they were supplied before natural tuberization. Treatments after that moment were somewhat less effective. Enhanced epinasty and leaf abscission were also observed following ethrel applications.

Introduction

Ethylene gas, probably the simplest organic compound specifically involved in plant growth and morphogenesis, is a natural product of plant metabolism, and it is active in very low concentrations (Burg, 1968). Most authors now consider it an endogenous growth regulator. Some characteristic effects normally associated with this substance are reduced elongation, increased radial expansion, accelerated fruit ripening, leaf abscission and epinasty (Pratt and Goeschl, 1969).

Ethrel (2-chloro-ethyl-phosphonic acid, also known as CEP or as Amchem-66-329), is a liquid product which provides a suitable alternative method for treatments with ethylene. The product is readily absorbed by plant organs, and it apparently breaks down within the tissues, releasing ethylene close to its site of action. The ability of ethrel to produce ethylene depends largely upon the pH, with more rapid release at the higher pH.

In the following, we are describing the results of a glasshouse experiment which was designed to study possible effects of ethrel on the potato plant. Two different vegetative stages were considered in this study: 1. before tuber initiation, and 2. after tuber initiation.

Material and methods

We used potato tubers of Turia variety (Solanum tuberosum L. var. Turia, super-elite). They were very uniform regarding both storage conditions and sprouting stage. At the planting date, the tubers were no longer dormant, but all sprouts were still smaller than 2 mm.
Fifty tubers were individually planted in plastic pots of 25 cm containing washed quartz sand with approximately 5\% vermiculite. These pots were watered every 8–10 days with Ohio State solution diluted to one-half, and every 3–4 days they received only water. In both cases approximately one litre was added per pot.

No artificial light was provided, so that the photoperiod gradually increased from 10 to 14 h during the three months which elapsed between the beginning and the end of the experiment. Average daily temperature was 20–22 °C with slight variations, except for occasional short periods (never below 15 °C or above 28 °C).

Planting date was January 18, 1971, and emergence took place in the middle of February. Then, two groups of 25 pots were established, the first to be treated before tuber initiation, and the second to be treated after tuber initiation. On March 1, the first group received one litre per pot of ethrel solutions, added to the sand, at doses of 0; 2.5; 25; 100 and 500 ppm, each dose being added to a subgroup of 5 pots. The plants were removed for observation in March 22, the same day that the second group was treated with equivalent ethrel doses. Plants of the second group were removed in April 13.

Each plant of each dose within the above two groups, was scored for:
1. tubers: number and weight
2. leaves: epinasty, abscission, number of leaves and leflets
3. stolons: number, length and weight
4. stems: number, length and weight
5. roots: weight

Results

Fig. 1 summarizes our results with regard to tuber induction. Ethrel clearly increased the number of tubers formed per plant, especially at concentrations of 100 ppm and 500 ppm supplied before the moment of natural tuber initiation (1A). When the treatment was done after tuber initiation, the effect was not so patent (1B). At this time of treatment, the optimum doses appeared to be lower (25 ppm and 100 ppm against 500 ppm for pre-tuberization treatments).

There was also some indication that the highest ethrel concentration (500 ppm) reduces total weight of tubers per plant (1C, D), at least in early stages of tuber development. In this case, one should be cautious in comparing pre- and post-tuberization treatments because they refer to tubers with different size, but a decrease in total weight was significant within each group.

Fig. 2 shows representative plants for each dose in the pre-tuberization group. More tubers, smaller in size, is the effect to be expected after an ethrel application if our results are fully confirmed.

Ethrel also induced epinastic bending on leaf petioles (Fig. 3A, B). This was stronger for doses of 100 ppm and 500 ppm when applied before tuber initiation. Finally, we observed ethrel-induced leaf abscission, probably non-significant when plants were treated prior to tuber initiation (3C), but significant in older plants (3D) treated with...