BRIEF PAPERS
RELATIONS OF PLANTS TO MINUTE DOES OF INHIBITIVE SUBSTANCES
ERNEST S. REYNOLDS

It is generally recognized that minute doses of substances which are toxic in larger quantities may act in a stimulatory fashion, that is, they may cause the plant to accelerate one or more of its activities in excess of any stoichiometric relationship. Minute traces of mineral salts (2, 4) and auxins, bioses, vitamins, and other growth accessories (1, 3, 7) which are of biological origin, all seem to show this action and, above certain specific concentrations, the toxic action of representatives of most of these classes of materials has been demonstrated. The action of these substances, however, is much more complicated than the just mentioned facts would indicate. Living organisms not only react by stimulation or retardation of their individual activities, but also ultimately become accommodated to increased or decreased quantities of physical and chemical stimulative factors. This accommodation or acclimatization may become evident in various ways. THIMANN (6) has briefly called attention to a type of adjustment which is of very great significance in physiological studies. He says: “If roots are treated with auxin so that they are inhibited, and the auxin afterwards removed, their subsequent growth is accelerated . . . . The higher the concentration of auxin used, the longer it takes for this acceleration to appear, but on the whole the greater the acceleration is when it does come.” Apparently referring to the same work WENT and THIMANN (8, p. 144) suggest that this reaction “presumably, is due to the rapid disappearance of auxin from the root, so that its concentration eventually reaches the accelerating level.”

Some recent observations incidental to another investigation, upon rooting of oleander cuttings in solutions of hetero-auxin indicated the same type of reaction. Three sets of cuttings were made on April 18, some cuttings being placed in tap water (set C), some in 0.0013 per cent. hetero-auxin in water (set B), and some in 0.02 per cent. hetero-auxin in water (set A). Those in set B were given fresh solutions twice in the next three weeks, at the end of which time they were placed in tap water. They had developed callus tissue, but no root initials were externally visible. On April 20 the cuttings of set A were washed off and placed in tap water. The first cutting to show root development was from set C; and by May 9, 9 out of the 10 in this set had developed roots. On the other hand, by this date all of the cuttings of sets A and B had developed more callus and overgrowth of tissue than those in set C, but no roots. Those of set A had the greatest amount of overgrowth. By May 16 numerous roots were showing on all 3 cuttings in
set A, but in set B on only one cutting had a root appeared. In general the number of roots formed on the cuttings of check set C was less than on those of set A. By June 1, 6 of the 12 cuttings in set B had developed roots while the others had not rooted by June 14 and were discarded. Thus it is evident that the hetero-auxin stimulated tissue growth of the stem, and retarded root elongation. On the other hand more root initials were formed in the auxin-treated cuttings than in the non-treated, but at a considerably later date. The cuttings in the dilute solution which had been kept in this solution for three weeks were much retarded in root formation and suffered otherwise since half of them died during the experiment. Of those in this set which survived, several produced very large well-developed root systems, and some of the control cuttings likewise finally developed root systems which seemed the equal of some of the auxin-treated cuttings. Since these cuttings were used in another investigation, exact quantitative results can not be given.

The internal mechanism by which this type of adjustment takes place is of course a part of the irritable quality of protoplasm, but probably in each instance the detailed reactions are specific and different. In the reporting of experimental results and in making deductions from them, this type of reaction seems to have been given little if any consideration. It seems probable to the writer that this same type of adjustment would be likely to take place whenever there is a quantitative change in any of the stimulative factors of the environment, within the life-limits of the given factor.

The writer (5) formerly called attention to an accommodation of plant growth to a toxic substance in the case of a fungus, *Fusarium lini*, under the action of KCN. The initial growth of the fungus was retarded and the later growth accelerated, roughly in direct ratio to the increased concentration of the cyanide. More recently a preliminary inhibiting action followed by stimulation has been reported by WRIGHT and ANDERSON (9), in the action of water soluble derivatives of 1, 2, 5, 6-dibenzanthracene on the growth and glucose utilization of *Fusarium lini*.

WENT and THIMANN (8, p. 143) state that the inhibition of roots by auxins "is not comparable with that produced by toxic substances" but they do not elaborate upon this. The inhibition and later stimulation of *Fusarium lini* by KCN seems to be similar, at least in certain aspects, to this root reaction to auxin. Presumably more of the KCN remained present in the cultures in which the highest concentration had been used than in the lower concentrations, while in the auxin treatment of the cuttings the external auxin solution was completely removed before stimulation appeared. This might not have been necessary if a more dilute solution had been used since other experimental results show that the auxin is stimulative in much more dilute solutions than were used. It is possible that above the range of
immediately stimulative concentrations and below the completely inhibitive ones there would be a range of concentrations in which the roots would become adjusted and finally stimulated.

In any case, this preliminary inhibition and final stimulation of plant tissues by toxic substances, thus indicating an accommodation of the organism to them, points to the necessity of a more careful consideration of this phenomenon in physiological experimentation.

WASHINGTON UNIVERSITY
AND
MISSOURI BOTANICAL GARDEN
ST. LOUIS, MISSOURI

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