INTERACTION BETWEEN GIBBERELLIC ACID AND INDOLE ACETIC ACID

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INTRODUCTION

GIBBERELLINS are now considered to represent a group of plant hormones with an action clearly distinguished from that of auxins. Treatment of a variety of plants with gibberellic acid (GA) was found to increase the shoot growth and the relation was directly proportional to the dose of applied GA (*see* Audus, 1963; Singh, 1967; Devlin, 1966).

Recently, El-Gobashy (1969) found that GA treatment significantly increased stem height, number of leaves, fresh and dry weight of shoots of soybean and *Ricinus communis.* The increase in shoot length of GA-treated plants was accompanied with a decrease in stem thickness and number of branches. In the case of soybean, an inhibition of root growth was observed in GA-treated seedlings.

The same author also found that stem apices of GA-treated soybean or *Ricinus* plants had more extractable endogenous auxins than those of the untreated plants, specially at the early stages of plant development. The activity level of such auxins was found to be proportional to the concentration of the applied GA.

The following experiments were carried out to show if there is any interaction between GA and indole acetic acid (IAA), using the hypocotyls and radicles of soybean and *Ricinus communis.*

MATERIALS

The test objects used in the present work were the hypocotyls and radicles of soybean and *Ricinus communis.* The seeds of the two plants were kindly provided by the Ministry of Agriculture of U.A.R.

Seeds of *Ricinus* and soybean were germinated on moistened cotton wool in large petri dishes in a dark room at about 30° C. Sections from uniform hypocotyls and radicles were excised from *Ricinus* seedlings when they were 6 days old and from soybean seedlings when they were 4 days old. The sections were excised from the upper meristematic part of the hypocotyls and from the meristematic zones of radicles next to the root tips.

EXPERIMENT I

Interation between GA at a Constant Concentration and IAA at Different Concentrations

Method.—A set of 9 solutions containing a constant concentration of GA and different dilutions of IAA (10^3, 10^2, 10^1, 10^0, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} ppm) was prepared. The concentration of GA used was the optimum concentration for the growth of the test plants. Thus, it has been found in a preliminary experiment that the optimum concentration of GA for the growth of *Ricinus* hypocotyl sections was 10 ppm, while it was 1 ppm in the case of soybean hypocotyl segments. With regard to the optimum concentration of GA for the root growth, it was found to be 10^{-4} ppm in the case of *Ricinus* and 10^{-5} ppm for soybean.

A control set of IAA at the same concentrations, just mentioned above, was also prepared in the absence of GA.

The activities of the different solutions of the 2 sets, in the presence and absence of GA, were assayed using hypocotyl and radicle sections of *Ricinus* and soybean seedlings. At the same time, control dishes of distilled water were also bioassayed.

The growth of hypocotyl and radicle sections, expressed as percentage of the control, was plotted against the concentration of IAA. The results are shown in Fig. 1 for *Ricinus* and in Fig. 2 for soybean.

Results.—When IAA was used alone, its relatively high concentrations inhibited the straight growth of the hypocotyl and radicle sections of the two plants under investigation. By further dilutions of IAA, the growth of the hypocotyl and radicle sections was gradually stimulated, reached a maximum value at an optimum concentration and then decreased at lower dilutions of IAA (*see* Figs. 1 and 2). The optimum concentration of IAA for the growth of *Ricinus* hypocotyls was 1 ppm while it was 10^{-1} ppm for soybean hypocotyls. With regard to the optimum concentration of IAA for the radicle growth, it was found to be 10^{-3} ppm and 10^{-4} ppm for *Ricinus* and soybean respectively.

When the optimum concentration of GA was added to the different dilutions of IAA, the growth of the hypocotyl and radicle sections of *Ricinus* and soybean was markedly increased as compared with the effect of IAA alone. The magnitude of such synergistic action of GA and IAA was more pronounced for the growth of hypocotyls than for that of radicles of the two plants (Figs. 1 and 2).

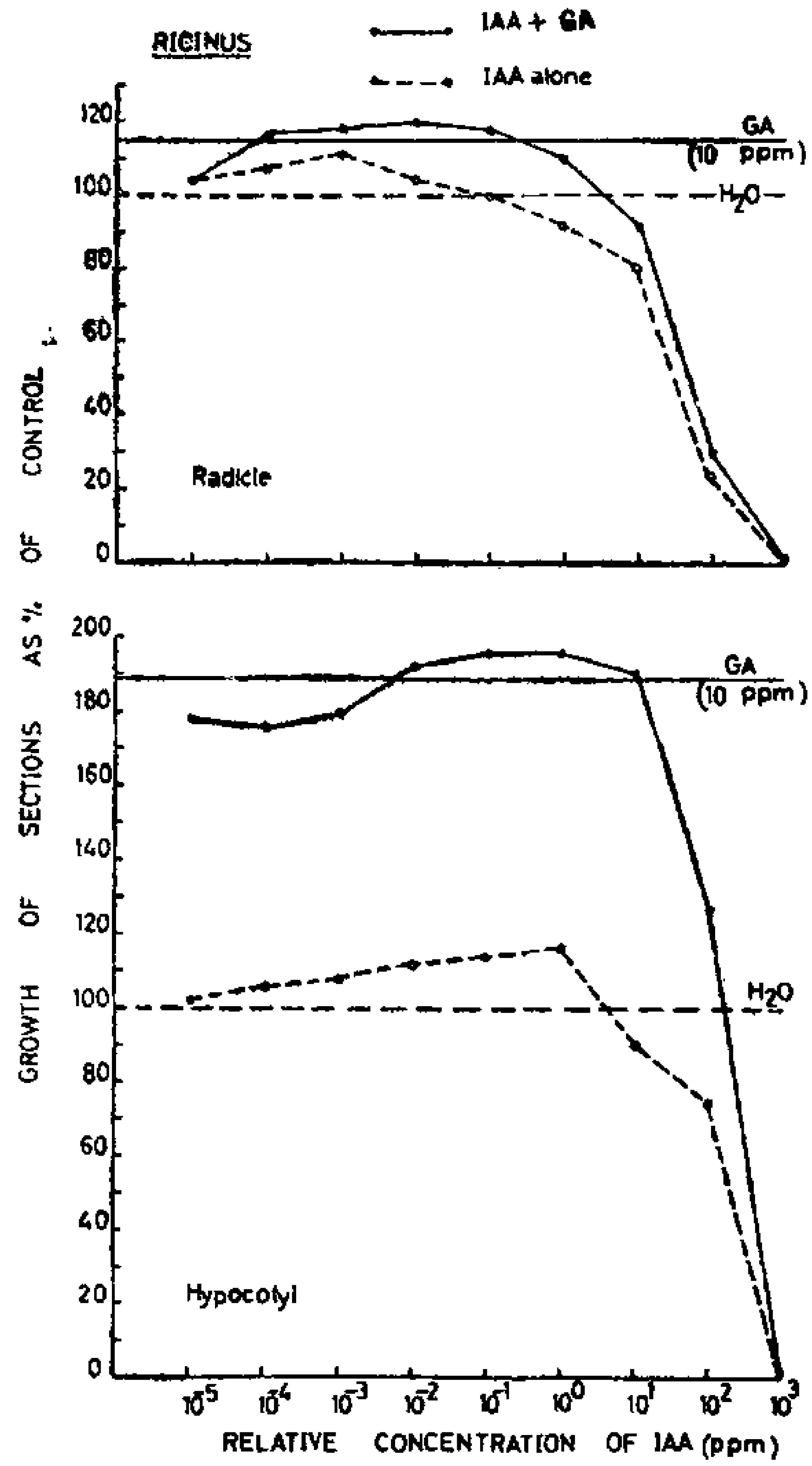

FIG. 1

EXPERIMENT II

Interaction between GA at Different Concentrations and IAA at a Constant Concentration

Method.—A set of 9 petri dishes containing a constant concentration of IAA and different dilutions of GA (10^3, 10^2, 10^1, 10^0, 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} ppm) was prepared. The concentration of IAA used, was the optimum concentration for the growth of the plant material as found in experiment I. The optimum concentrations of IAA for the growth of hypocotyl sections was 1 ppm in the case of *Ricinus* and 10^{-1} ppm in the case of soybean. For the radicle growth of *Ricinus* and soybean the optimum concentrations of IAA were 10^{-4} ppm and 10^{-3} ppm respectively (*see* Figs. 1 and 2).

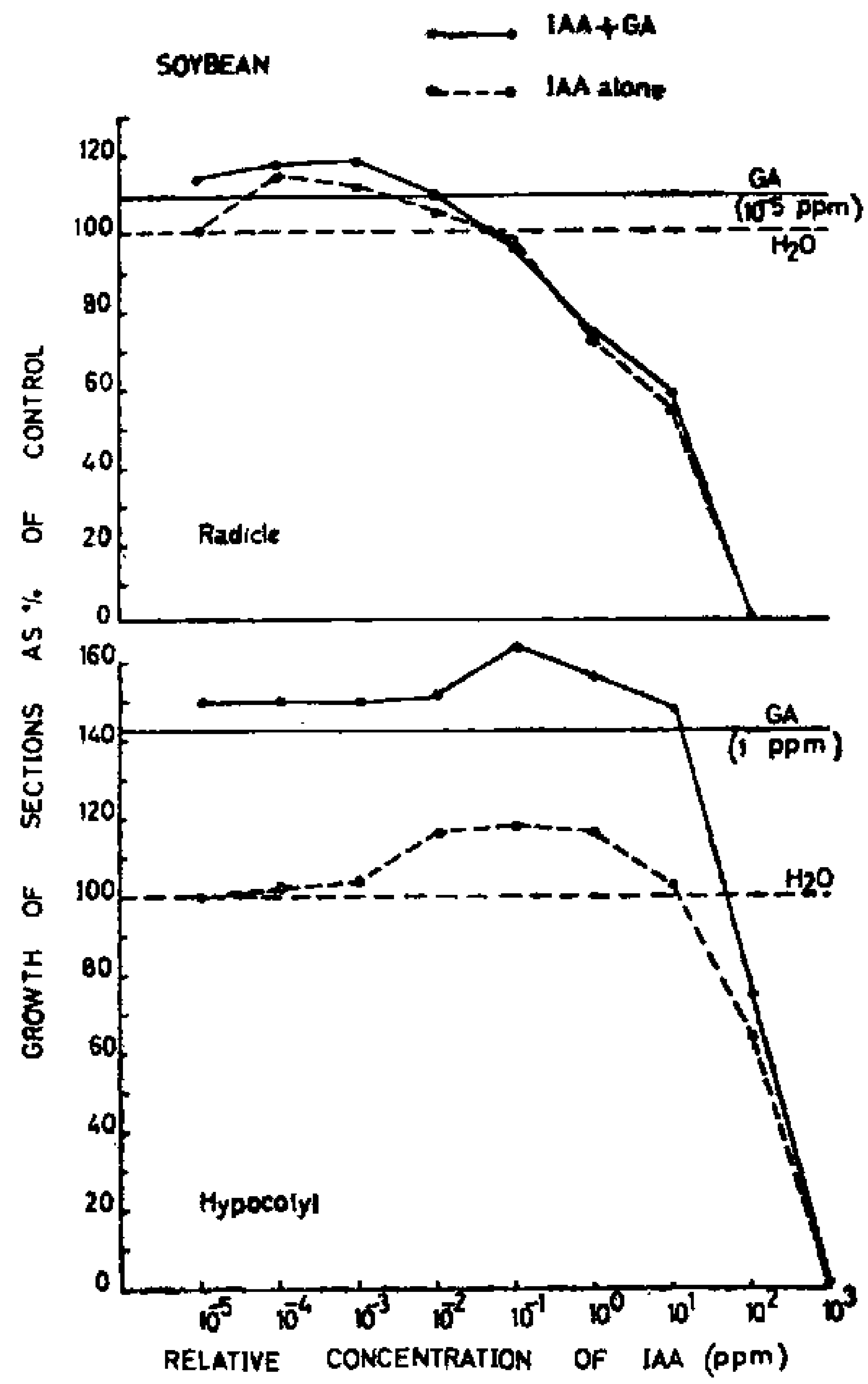

FIG. 2

Another set of 9 dishes containing the abovementioned concentrations of GA, in the absence of IAA, was also prepared.

The activities of the different solutions of the two sets, in the presence and absence of IAA, were assayed by hypocotyl and radicle sections of the 2 plants under investigation. Control dishes of distilled water were also bioassayed. The results are expressed graphically in Fig. 3 for *Ricinus* and in Fig. 4 for soybean.

Results.—The growth of the hypocotyl and radicle sections of *Ricinus* and soybean was inhibited by the relatively high concentrations of GA (Figs. 3 and 4). At lower concentrations, GA stimulated the growth of the plant sections. The optimum concentration of GA for the growth of the hypocotyl sections was shown to be 10 ppm and 1 ppm for *Ricinus* and soybean respectively. For the radicle growth, the optimum concentrations of GA were found to be 10^{-4} ppm in the case of *Ricinus* and 10^{-5} ppm for soybean.

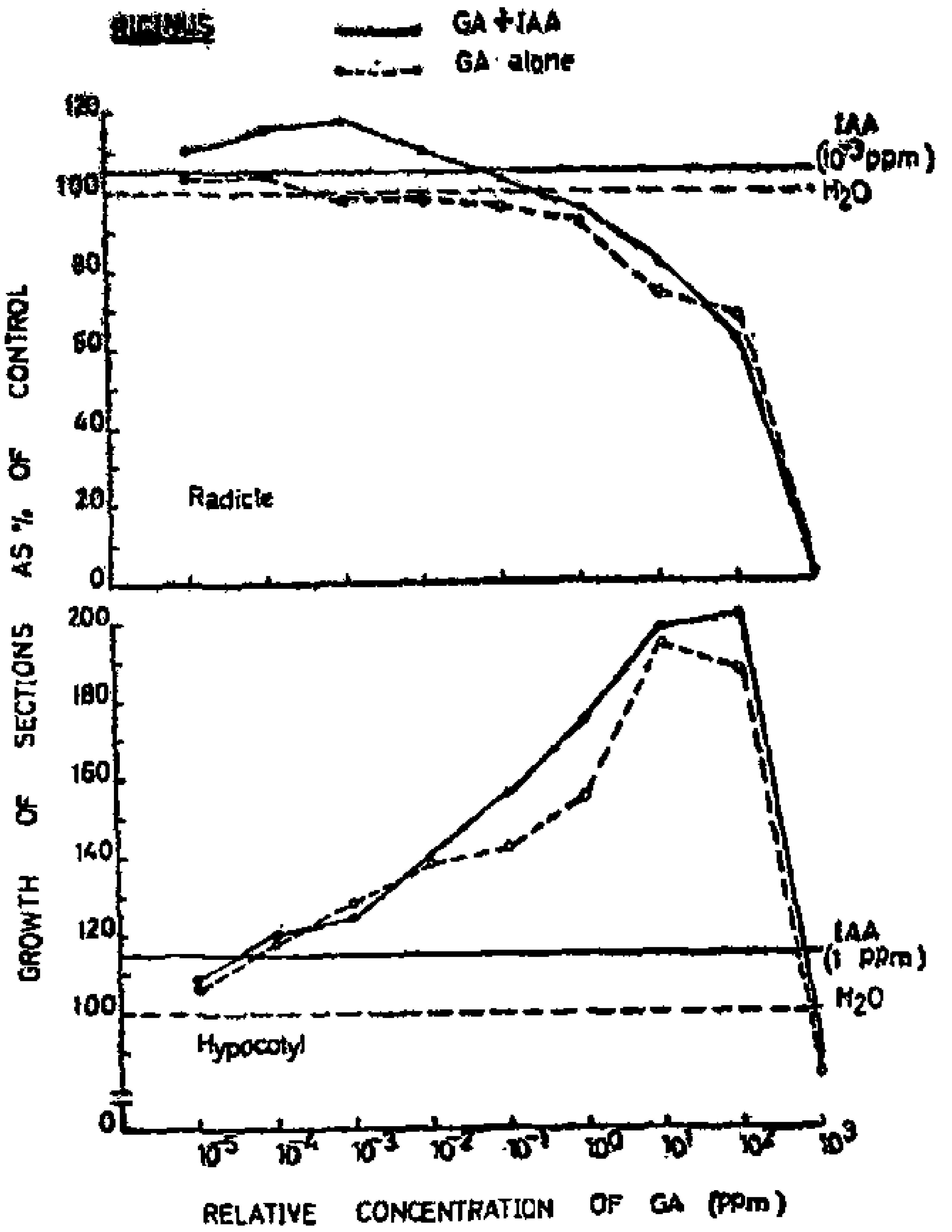

FIG. 3

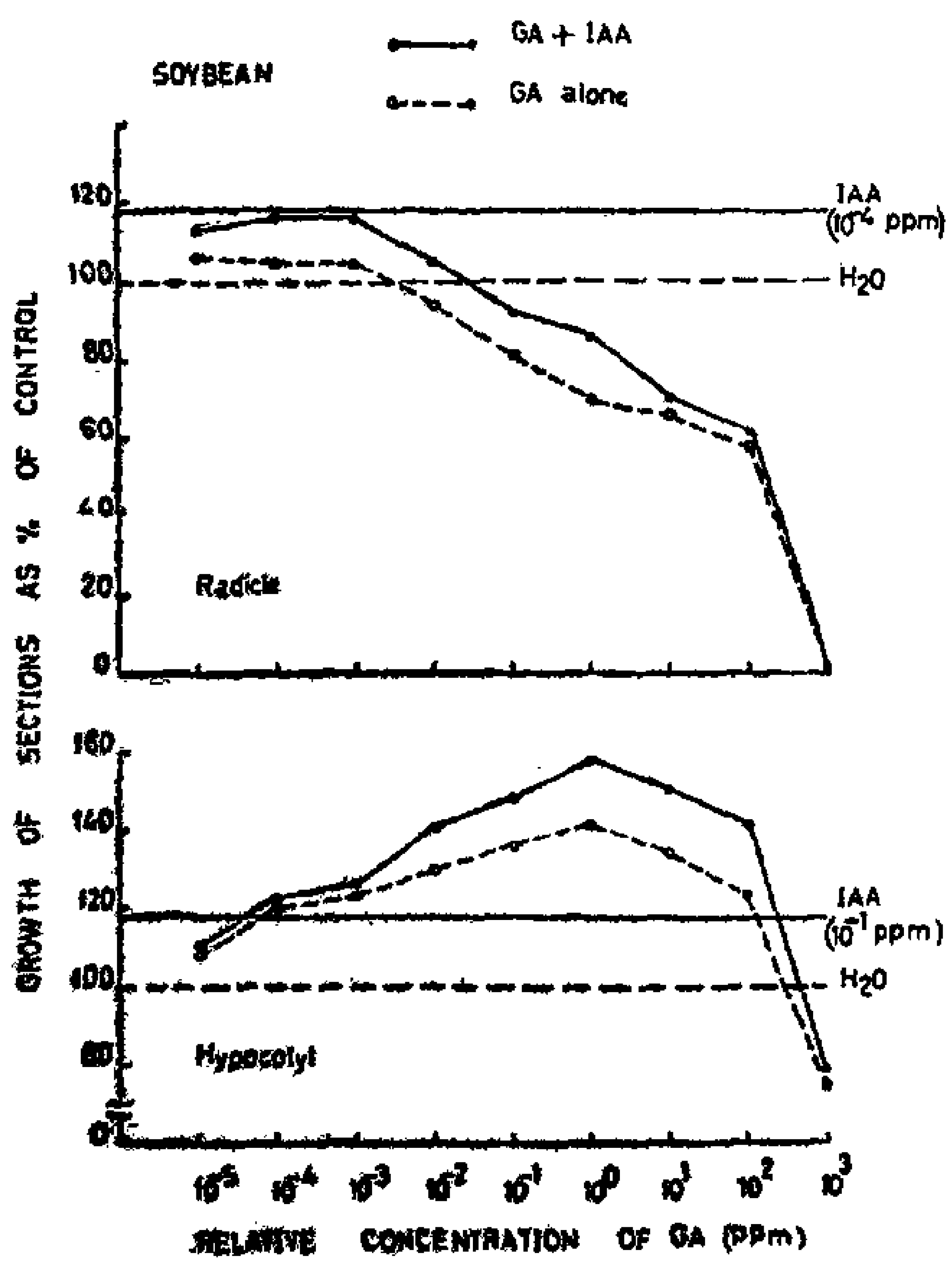

FIG. 4

When the optimum concentration of IAA was added to the different dilutions of GA, they showed a synergistic action on the growth of the hypocotyl and radicle sections of both *Ricinus* and soybean (Figs. 3 and 4).

Discussion

The possibility that gibberellin acts by protecting or stimulating native or exogenous auxins has been raised by a number of workers (Paleg, 1965 ; El-Gobashy, 1969).

In the present investigation, a synergistic action is found between GA and IAA. Such synergism was more evident in case of hypocotyl growth of *Ricinus* and soybean than in case of their radicle growth. In support of this observation Brian and Hemming (1961) reported that synergism could be demonstrated not only between GA and IAA but also between GA and certain synthetic auxins.

A very tempting explanation of GA and IAA synergism is that GA directly or indirectly inhibits metabolic destruction of IAA. Another satisfactory explanation is that gibberellin may stimulate some steps in the biosynthetic pathways of auxins (Paleg, 1965). Supporting this view, Kuraishi and Muir (1964) and Muir (1964) have found that treatment of tomato ovaries or dwarf pea apices yields preparations that were able to convert tryptophan to auxin at a greater rate than preparations from untreated plants.

Summary

A possible interaction between gibberellic acid (GA) and indole acetic acid (IAA) was investigated using the hypocotyls and radicles of soybean and *Ricinus communis* as test objects. There was a marked synergistic action between GA and IAA. Such synergism was much more evident in case of hypocotyl growth than in case of radicle growth.

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1. Audus, L. J., *Plant Growth Substances*, Leonard Hill (Books) Limited, London, 1963.
2. Brian, P. W. and Hemming, H. G., *Nature*, 1961, **189**, 74.
3. Devlin, R. M., *Plant Physiology*, Reinhold Publishing Corporation, New York, 1966.
4. El-Gobashy, A. S., "Physiological studies on gibberellic acid," *Ph.D. Thesis*, A'in Shams University, Cairo, 1969.
5. Kuraishi, S. and Muir, R. M., *Plant and Cell Physiol.*, 1964, **5**, 61 & 259.
6. Muir, R. M., *Plant Physiol.*, 1964, 39, Suppl. XVII.
7. Paleg, L. G., *Ann. Rev. Plant Physiol.*, 1965, **16**, 291.
8. Singh, A., *Plant Physiology*, Asia Publishing House, New York, 1967.