THE INFLUENCE OF GIBBERELLIC ACID AND METHYL ESTER OF INDOLYLACETIC ACID ON THE GROWTH OF COLEOPTILE SECTIONS AND MESOCOTYLES OF MAIZE SHOOTS OF VARIOUS AGE

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It is known that auxins of the type of β-indoleacetic acid (IAA) and gibberelic (GA) activate the growth of plant cells in the phases of division and elongation [1--5], and their action on these processes depends on the physiological state of the tissues and on the conditions of the external environment. In our work we studied the growth reaction to GA and methyl ester of IAA (mIAA) of coleoptile sections and mesocotyle sprouts of maize depending on age and temperature.

The shoots of maize of the Bukovinskaya variety were cultivated in the manner described by V. V. Polevoy and K. Z. Gamburg [6]. Sections of coleoptiles and mesocotyles, which were cut in weak (10—20 luxes) daylight, were maintained prior to the test for two hours in distilled water for increasing their sensitivity to GA and mIAA. The sections were incubated for 24 hours in the dark in Petri dishes with 20 ml of distilled water (control) or aqueous solutions of GA and mIAA. The length of sections prior to the beginning of the test and after incubation was measured with the help of an apparatus for the reading of microfilms. The tests were repeated 3—6 times. The reliability of results obtained, calculated by Styudent tables, comprised 97—98%.

In the study of the influence of GA on the growth of different age groups of coleoptiles it was shown that those reacting most strongly to GA were whole isolated coleoptiles with an age of 72 hours (15—18 mm), more weakly in the age group of 96 hours (32—35 mm), and very weakly in the age group of 120 hours (45—48 mm). A reverse picture was observed for mIAA (Fig. 1). Both for GA and for mIAA the optimum concentration was 10 mg/l. The mIAA strongly activated the growth of sections of mesocotyles of all ages, and GA more strongly - those of 96-hour growth. Here the 72-hour mesocotyles were removed completely, and for 96 and 120-hour mesocotyles

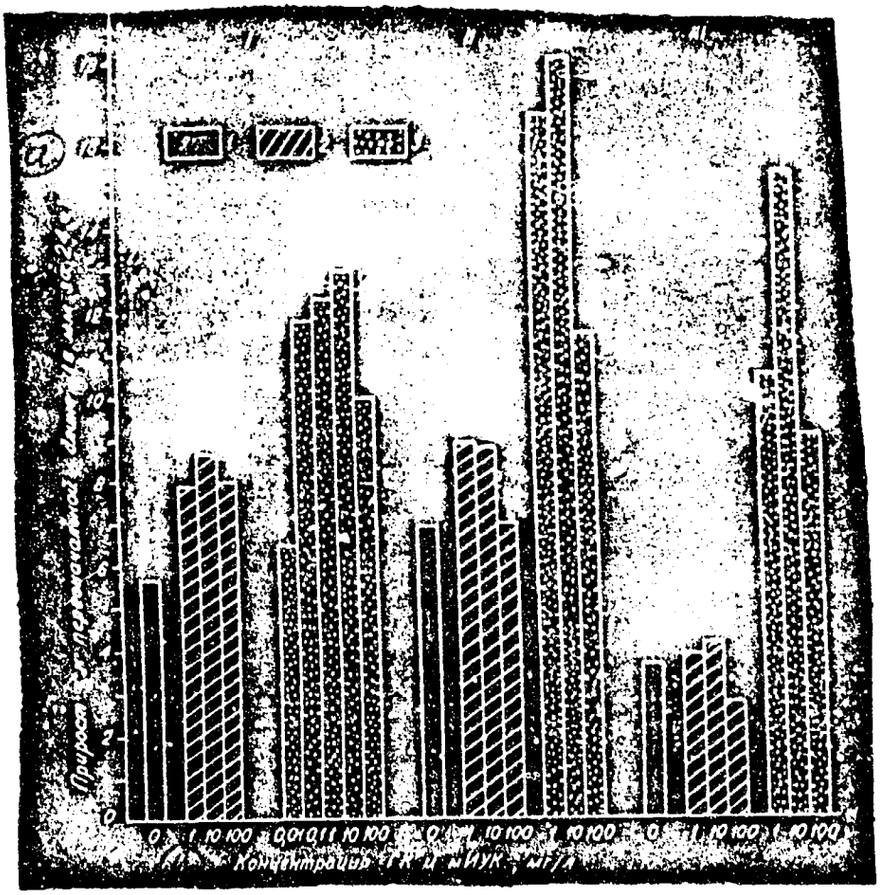


Figure 1. Influence of GA and mIAA on the growth of isolated coleoptiles of maize shoots with a removed summit at an age of: I - 72 hours; II - 96 hours; III - 120 hours. 1 - Control; 2 - GA; 3 - mIAA.
Key: (a) Amount of growth up to initial length (in mm for 24 hours); (b) Concentration of GA and mIAA, mg/l.

only the upper 10—11 mm were used (Fig. 2). In the tests with mesocotyles the optimum concentrations for GA were 10—100 mg/l, and for mIAA - 1—10 mg/l. Thus, for GA the young coleoptiles reacted best, and to mIAA - the older ones. This agrees with the data of S. Wrigth [7], who showed that the strongest growth reaction to GA (10^{-6} M) is displayed by wheat coleoptiles at the age of 18 hours, and to IAA (10^{-4} M) - at an age of 54 hours.

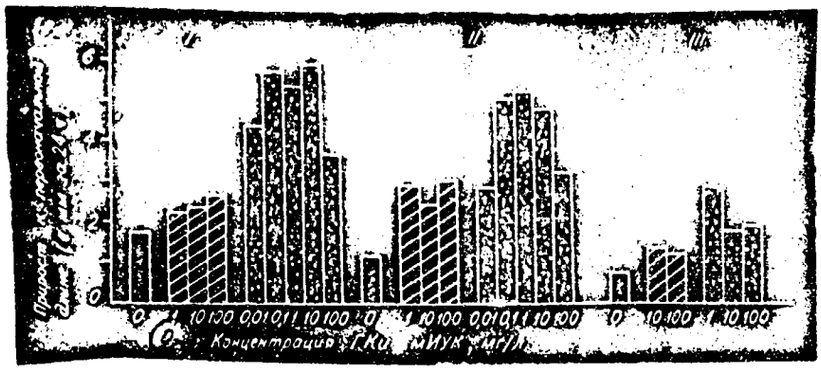


Fig. 2. Influence of GA and mIAA on coleoptile sections of maize shoots at the age: I - 72 hours (whole mesocotyles); II - 96 hours (upper 10 mm); III - 120 hours (upper 10 mm). 1 - Control; 2 - GA; 3 - mIAA.
Key: (a) Amount of growth up to initial length (in mm for 24 hours); (b) Concentration of GA and mIAA, mg/l.

Fig. 3. Influence of GA and mIAA on the growth of coleoptile sections of maize shoots by zones. A - Shoots at the age of 120 hours, B - Shoots at the age of 96 hours. I - upper zone; II - middle zone; III - lower zone. 1 - Control; 2 - GA; 3 - mIAA.
Key: (a) Amount of growth up to initial length (in mm for 24 hours); (b) Concentration of GA and mIAA, mg/l.

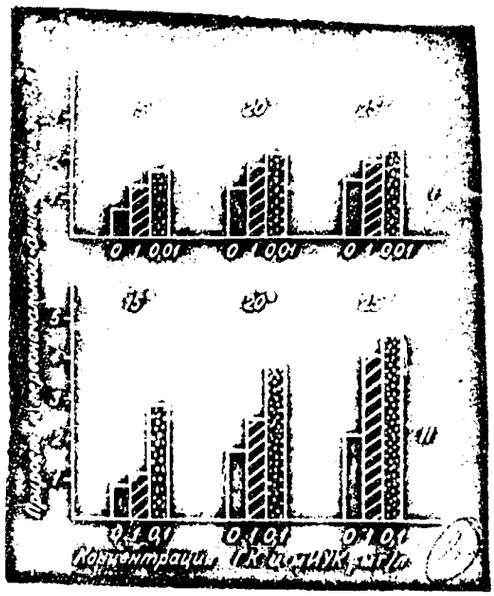
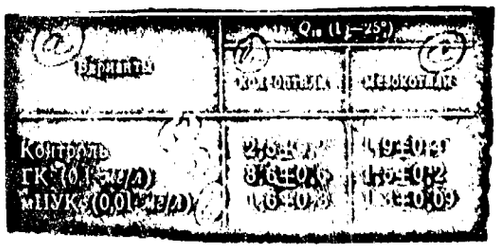


Figure 4. Influence of GA and mIAA on the growth of mesocotyle sections and coleoptiles of 96-hour shoots of maize at various temperatures. I - Mesocotyles (upper 10 mm); II - Coleoptiles (lower zone, 10 mm). 1 - Control; 2 - GA; 3 - mIAA.
Key: (a) Amount of growth up to initial length (in mm for 18 hours); (b) Concentration of GA and mIAA, mg/l.

Change Q_{10} in growth of sections of coleoptiles and mesocotyles of 96-hour shoots of maize under the influence of GA and mIAA



Key: (a) Variant; (b) Coleoptiles; (c) Mesocotyles; (d) Control; (e) GA (0.1 mg/l); (f) mIAA (0.01 mg/l).

In a study of the reaction of separate zones of coleoptiles to GA and mIAA it was established that GA activates the growth of the lower zone of the coleoptile considerably more strongly than the upper and middle (Fig. 3). All the zones reacted to mIAA, but most of all the lower. J. Matti [8], on the other hand, demonstrated an intensification of growth under the influence of IAA of only the upper zone of 96-hour wheat coleoptiles, and T. Barlow [9] observed the uniform influence of IAA on the upper, middle, and lower zones.

The stimulating effect of GA and mIAA depends on temperature. P. Ray [10] found that IAA (3 mg/l) influences the growth of oat coleoptiles considerably more strongly at 15° than at 25°. T. Sudia [11] reported of the greater stimulation of growth of the coleoptile and primary leaf of barley shoots at 25° and lesser at 15 and 18° under the influence of GA (0.001—10 mg/l). On whole plants of beans and peas it was shown [12, 13] that the action of GA does not depend on temperature. In our experiments with an increase of temperature the absolute growth of sections of coleoptiles (lower zone) and mesocotyles (upper 10—11 mm) in the presence of and absence of GA and mIAA was increased. However, the growth of sections of coleoptiles relative to the control under the influence of GA was increased with an increase of temperature (from 136.5 to 190.0%), and under the influence of mIAA was decreased (from 348.1 to 222.2%). In tests with sections of mesocotyles a somewhat different picture was observed: with an increase of temperature a drop was observed in the stimulating action of GA and mIAA (in % relative to the control) (Fig. 4).

It is necessary to note that in the tests with sections of coleoptiles the Q_{10} for GA was usually 2 times higher than for mIAA, and in tests with sections of mesocotyles the Q_{10} was almost the same (see table). It is possible that the nature of the effect of GA on tissues of coleoptiles and mesocotyles is somewhat different.

Conclusions

1. Gibberelic acid (GA) and methyl ester of IAA (mIAA) activated the growth of tissues of coleoptiles of maize, while in all cases mIAA exerted a stronger effect than GA.

2. GA in a concentration of 1—10 mg/l considerably accelerated the growth of young coleoptiles, and mIAA in a concentration of 0.01—10 mg/l - of old.

3. The upper, middle, and lower zones of 72 and 96-hour coleoptiles reacted to GA and mIAA with an acceleration of growth, while the lower was the greatest.

4. GA does not influence the growth of upper and middle zones of 120-hour coleoptiles.

5. GA and mIAA stimulate the growth of mesocotyles of all ages, while the most significant was on 96-hour specimens.

6. The activating effect of mIAA (0.01 mg/l) on the growth of the upper zone of mesocotyles and the lower zone of coleoptiles of 96-hour shoots is lowered with an increase of temperature from 15 up to 25°. An increase of temperature by 10° is expressed in the same manner on the growth of the upper zone of mesocotyles under the influence of GA (0.1 mg/l). However, the lower zone of coleoptiles under these conditions react differently: GA accelerates its growth considerably more strongly at 25° than at 15°.

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