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Studies on the Physiological Effect of Gibberellin.
I. On the Differential Activity between Gibberellin and Auxin

By

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When the seedling of rice-plant is infected by *Gibberella Fujikuroi* (*Saw*) *Wollenweber*, it becomes lanky and light green. Yabuta, Sumiki and co-workers (6, 7, 8, 9, 10, 11) separated from the culture medium of the fungus two substances which made various plants grow in a similar way as the infected rice seedling. These substances were named gibberellin A and B after the name of the fungus.

Studies of gibberellin which is a very effective growth regulator are important because: (1) the substance has a characteristic effect to make many kinds of plants growing in daylight have an appearance as if they were growing in very dim light; (2) it might provide with a special clue, besides auxins, to elucidate the mechanism of the stem elongation; and (3) various practical applications may be found owing to its special effect. The present report shows the unique nature of gibberellin in contrast to auxin.

The gibberellin preparation used in the present investigation contains both of gibberellin A and B unseparated. The abbreviations GB and IAA stand for gibberellin and indole-3-acetic acid, respectively, in this report.

Experimental

1. Growth Promoting Effect. Seedlings of soybean, sunflower and tomato, growing in soil-filled flats in the green house, were used. When they were 2–3 cm. high, 0.1% lanolin paste of GB was smeared on the basal part of every cotyledon about 2 mm. wide. The effect of GB stimulating stem elongation was observable 2 3 days, and was very remarkable several days, after the application. Table I shows one of the typical results. As seen in Fig. 1, the internode is longer and the leaf area is smaller with treated plants compared to the control plants which were treated with plain lanolin. So the GB-treated plants looked like etiolated ones, except that they were as green as the normal plants.*)

*) When the concentration of GB is higher, the treated plants tend to be lighter coloured.

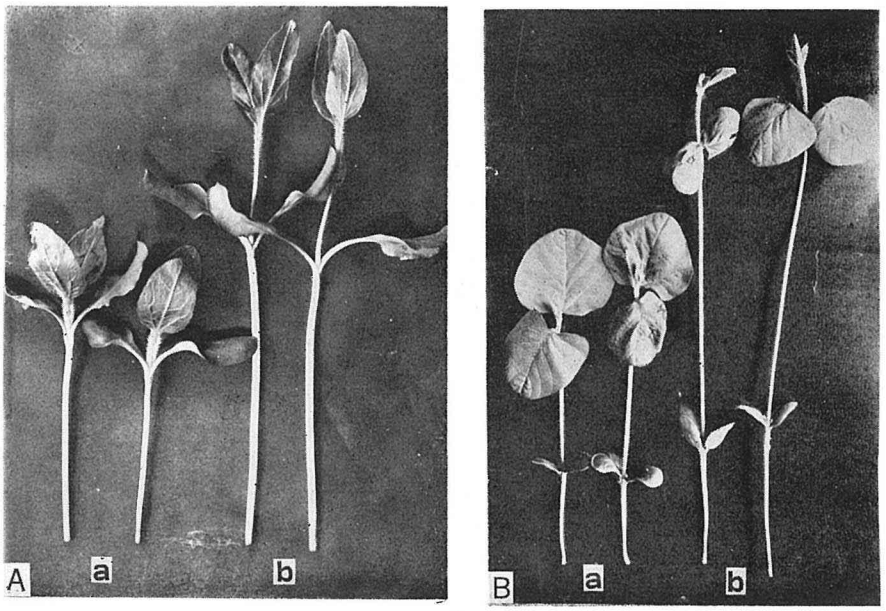

Figure I. Plant treated by lanolin paste.
A. Sunflower : (a) Control, (b) 0.1% GB, 13 days after treatment.
B. Soybean : (a) Control, (b) 0.1% GB, 10 days after treatment.

Table I. Effect of 0.1% GB lanolin paste on the elongation of seedlings.
Each value represents average of 7–12 plants.

Material	Experimental period	Elongation (cm.)		Increase over control %
		Control	GB	
Soybean	10/2/51–10/11/51	13.8	27.6	100
Sunflower	10/24/51–11/5/51	5.7	11.3	100
Tomato	6/6/50–6/12/50	1.8	6.8	273

2. TESTS FOR AUXIN ACTIVITY. *Avena and pea tests.* The standard *Avena* test and the pea test were made after Went and Thimann (5), in the darkroom kept at 25°C. The concentrations of GB solution used were 1000, 500, 100, 50, 30, 20, 10 and 1 mg./l. in the *Avena* test, and 1000, 100, 50, 30, 20, 10 and 1 mg./l. in the pea test. But no auxin-like effect was observed with any of the concentrations used in both of the tests.

Epinasty. One per cent lanolin paste of GB was applied on leaf petioles of tomato plants which were grown in the green house and were 36–40 cm.

high. No epinastic response was seen at any time after the application (Table 2). And the induction of root, too, was not observed on the aerial part of the treated plants. As to be expected, the epinasty and the induction of root were conspicuous with the plants treated on the same occasion by 1% lanolin paste of IAA.

Table 2. Effect of 1% GB and 1% IAA lanolin paste on the epinastic movement of petioles of tomato. Angle between stem and petiole in degrees, each value representing average of 6 plants.

Petiole No. from top	GB			IAA			Pure lanolin		
	Before treat.	24hrs. after treat.	Diff.	Before treat.	24hrs. after treat.	Diff.	Before treat	24hrs after treat.	Diff.
1	33	33	0	30	95	65	29	29	0
2	38	38	0	38	117	79	38	38	0
3	39	39	0	41	115	74	38	38	0
4	43	43	0	33	117	81	39	39	0
5	39	39	0	33	112	79	43	43	0
6	35	35	0	37	105	68	40	40	0
Av. epinastic movement			0°			74.8°			0°

Callus formation. Sunflower and tomato seedlings, growing in the green house, were decapitated at 1 cm. above the cotyledons. The cut surfaces were treated by 1 and 0.1% GB, and plain lanolin paste. And the treated stumps were left in the green house. Seedlings of *Vicia Faba* which were growing in the darkroom at 25°C. and 20–25 cm. high, were decapitated just below the second node. The cut surfaces were treated by the above mentioned three kinds of lanolin paste, and were left in the dark. But no callus formation or swelling was observed at and near the cut surface of any of the treated seedlings.

Effect on the growth of lateral bud. Kidney bean seedlings growing in the green house, and pea seedlings growing in the darkroom of 25°C. were used. Beans were decapitated at 1 cm. above the cotyledonary buds, and peas at 1 cm. above the first scale. And lanolin paste containing 1% of GB or of IAA, or nothing, was smeared on the cut surfaces. They were kept in the same conditions as before the treatment. Table 3 shows the length of lateral bud 8 days after the smearing. The 1% GB did not inhibit, but on the contrary accelerated the elongation of lateral buds. The stimulating effect was more remarkable with bean.

Table 3. Effect of 1% GB and 1% IAA lanolin paste on the growth of lateral bud of kidney bean and etiolated pea seedlings. The value for bean represents the sum of the lengths of the pair of cotyledonary lateral buds. The value for pea, however, represents the length of a single bud, as only one of the axillary buds developed. Each value represents the average of 13–16 plants.

Material	Length of lateral bud after 8 days (cm.)		
	Control	GB	IAA
Bean (green)	9.7	79.6	0
Pea (etiolated)	15.7	19.8	0

Discussion

The effect of GB inducing hyperelongation, as reported by Yabuta *et al*, is reconfirmed in the present investigation by applying lanolin paste on soybean, sunflower and tomato in the green house. With 0.1% paste, the increased elongation of the stem was 100% or more of the growth of the control, the growth of the leaf blade being suppressed at the same time. But the green colour did not become lighter or yellowish, as reported on the case of culturing plants by nutrient solution containing GB, or the case of treating them with lanolin paste containing higher dosage of GB. According to unpublished experiments of the author, 0.1–1.0 mg./l. solutions of GB accelerate the multiplication of frond of *Lemna paucicostata*, 0.5mg./l. being the optimum. The fronds grown on these GB solutions were smaller in the average area, and lighter green in colour, than the normal ones. On the other hand, the multiplication of frond was inhibited by 1 mg./l., and stimulated by 0.5 mg./l. of IAA, the fronds grown on the latter solution being larger in their area and somewhat deeper green in colour than the control.

That the physiological effect of GB is quite different from that of auxin is proved definitely by the fact that GB is active neither in the *Avena*, the pea, and the tomato tests, nor in inducing callus and root formation. How is GB inactive in the former three tests, whereas it promotes elongation? Wada (4) have reported that the elongation ratio of the cell of staminal hair of *Tradescantia reflexa* cultured in the agar plate containing 0.0001% GB was larger than that of the control. But no curvature would result, if GB promotes elongation of both sides of the test pieces at the same rate due to symmetrical distribution in the pieces, or if the growth promotion does not appear in 24 hours which is the period of the observation. The mode of action of GB has to be known.

How the shape and number of cells are changed by GB, is under investigation. But it has become clear by the present investigation that the

cells are not stimulated by GB to multiply so as to make the cut portion of the stem swell out.

Summary

By the application of lanolin paste of gibberellin, internodes of seedlings of soybean, tomato and sunflower elongated abnormally, the leaf growth being suppressed at the same time. But the green colour was almost normal with 0.1% paste.

Gibberellin was inactive in all of the five kinds of test for auxin. Hence it is a growth regulating substance of the nature quite different from the auxin group.

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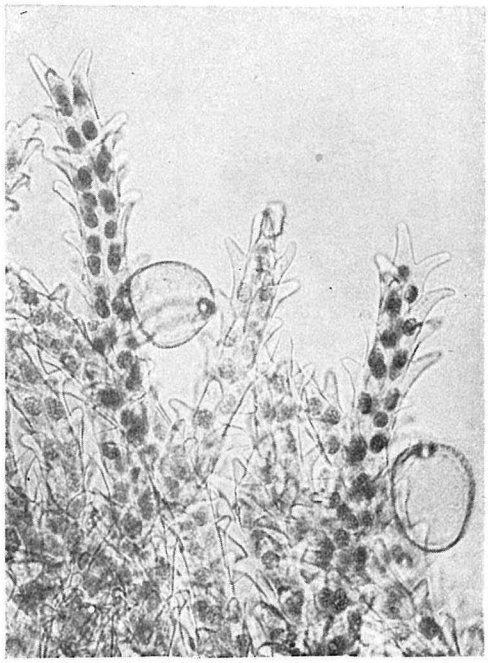

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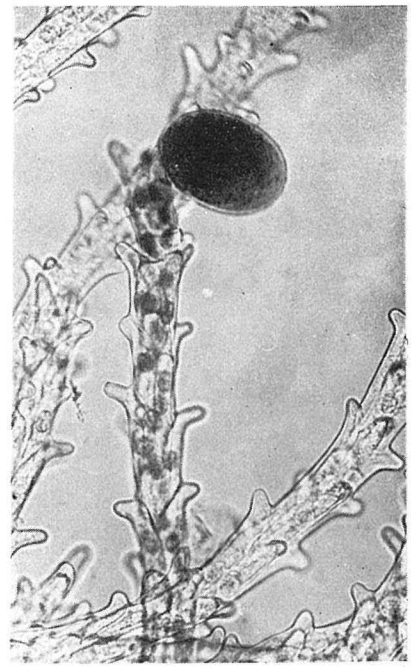

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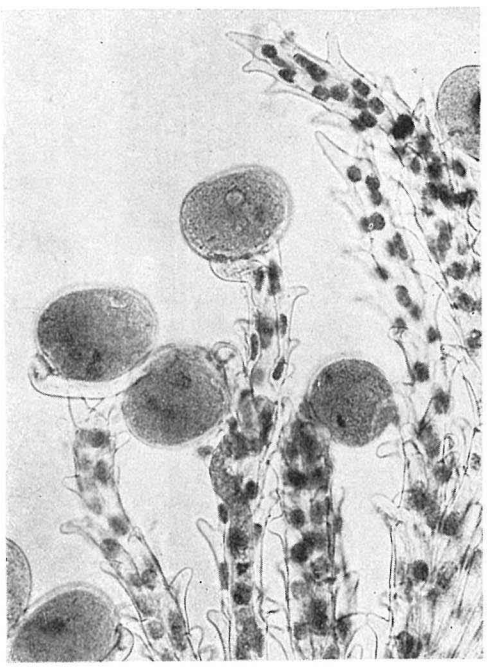

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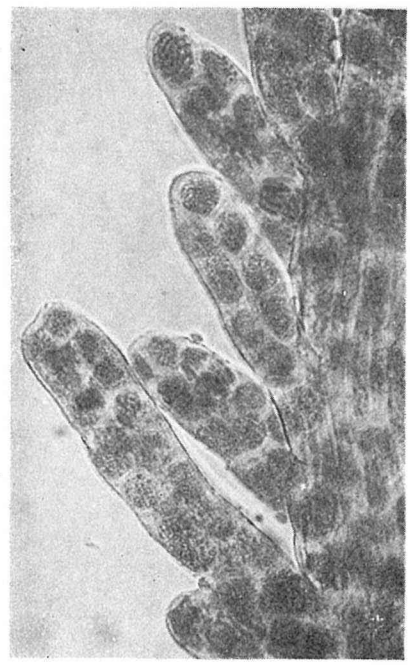

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