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Studies on the Growth Response of the Rice Plant to Exogenous Gibberellic Acid

I. Response of the Japonica Rice Seedlings to Applied Gibberellic Acid under Light and Dark Conditions

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Summary

In an attempt to elucidate the relationship between the effects of applied gibberellic acid (GA) and light on the growth of Japonica rice seedlings, a number of rice varieties were grown under continuous light (3,000 lux) and in darkness, respectively. The growth response of the seedlings to GA (1 μg/ml) were compared. Application of GA enhanced the growth of the seedlings in every case. However, the relationship between the effects of applied GA and light on the ordinary Japonica varieties varied with the plant organ, *i.e.*, the primary leaf and the second leaf-blade reponded to GA about the same in the dark as in the light, but the promoting effect of GA on the elongation of the second leaf-sheath was much greater in the light than in the dark. Growth response of the second internode to GA appeared only in the dark condition.

It has been known that stem growth is suppressed by light and enhanced by the applied GA in most higher plants (1). The present experiments were undertaken to elucidate the relationship between the effects of exogenous GA and light on the growth of Japonica rice seedlings.

Materials and Methods

Experiment 1.

Twenty-four Japonica varieties cultivated in the north-eastern district of Japan, four Japonica dwarf varieties and one Indica variety were selected. All the varieties were grown on the paddy field of the University experimental farm and the seeds were harvested in the fall of 1966. The experiment was conducted from April to June in 1967.

The seeds were sterilized with a 0.1 *per cent* solution of "Uspulun" for six hours at room temperature. Then they were washed with tap water and kept in a

Petri dish at 30°C in the dark. When the emerging coleoptiles reached about 1 mm in length, uniform seedlings were selected. Five seedlings were placed in a glass tube (21 mm in diameter and 90 mm in height) containing a 1 ml solution of GA (0 and 1.0μg/ml), and the tube was sealed with a sheet of "Parafilm". Three tubes were allotted to one variety. Then they were divided with some under continuous white fluorescent lamp illumination (3,000 lux) and others in darkness. After ten days' incubation, the length of the primary leaf, the second leaf-blade, the second leaf-sheath and the second internode were measured.

Experiment 2.

Seventeen Japonica varieties excluding those of the north-eastern district were selected. The seeds were obtained on the experimental farm in the fall of 1967, and the experiment was conducted in April of 1968. After fifteen days' incubation under the same conditions as described in Experiment 1, the length of the organs were measured.

In both the experiments, the growth response to GA of each organ was indicated as follows; (final length of GA treatment−final length of water control)/ final length of water control $\times 100$ (%).

Results and Discussion

The Effects of GA on the Elongation of the Primary Leaf, the Second Leaf-blade and the Second Leaf-sheath under Continuous Light and in Darkness

The results of Experiment 1 and 2 are represented in Fig. 1, in which a symbol denotes a variety. The distribution pattern of the primary leaf was nearly the same as that of the second leaf-blade, and a majority of the varieties were distributed on the lower left half of the figure. The distribution of the second leaf-sheath depicted the other pattern, and most varieties were located on the upper left fourth of the figure. These results suggest that the growth action of GA on the primary leaf and the second leaf-blade are nearly independent of the light conditions, but that there is some interaction between the effects of applied GA and light in the case of the second leaf-sheath. The two dwarf varieties (Waito-C and Tanginbozu) were highly responsive to GA in the dark and/or in the light. Similar results were obtained by Hayashi and Murakami (2). The other dwarf variety (Bungetsu-to) showed the lowest response of the primary leaf and the second leaf-sheath to GA in the light. These results suggest that the occurrence of dwarfism is associated with the shortage of endogenous GA in the former varieties, and not in the latter. The Indica variety (Boshi-to) showed a different pattern of response.

The response of the second leaf-sheath to light was greater than that of the second leaf-blade among all varieties tested (unpublished data). The same results were obtained by Bokura (3).

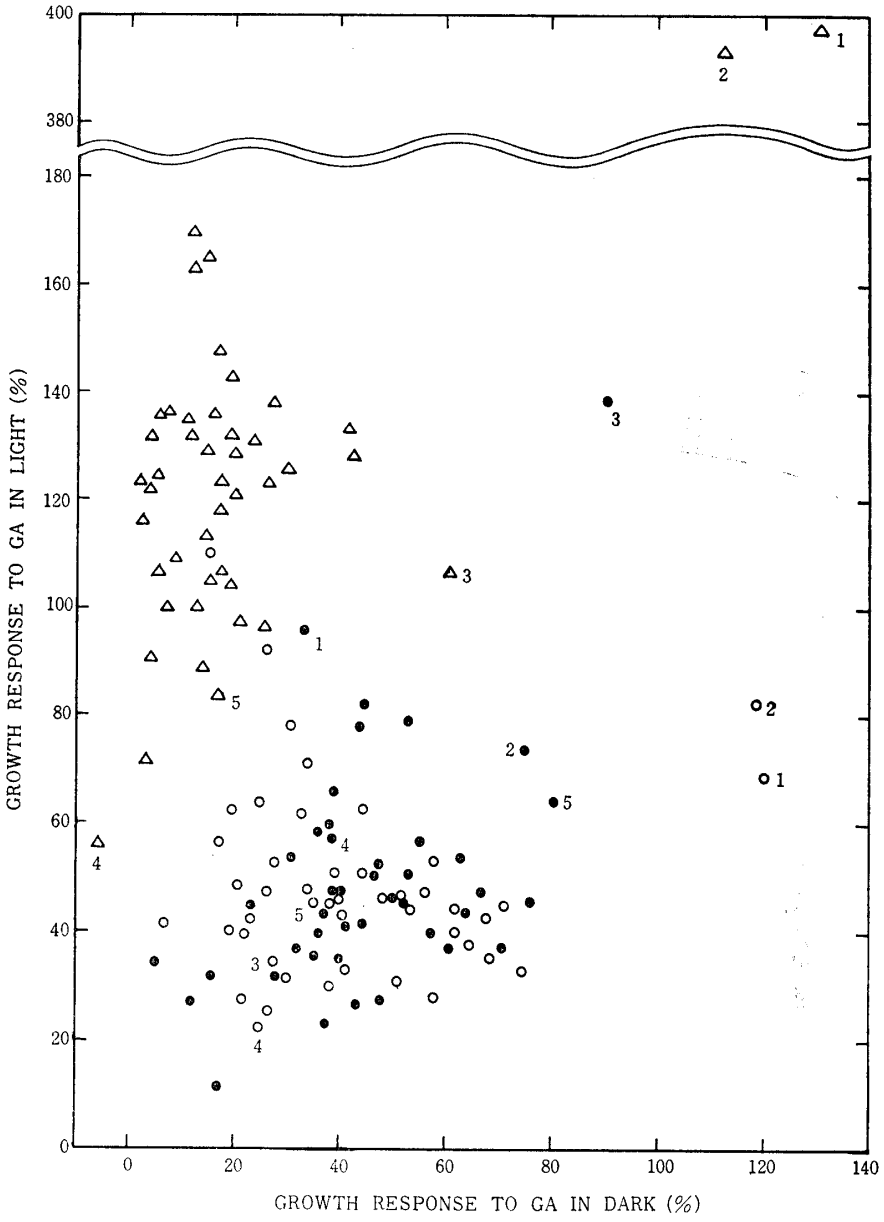

FIG. 1. Growth response of rice varieties to 1 μg/ml solution of GA in the dark and in the light (3,000 lux). Growth response of the primary leaf (○), the second leaf-blade (●), and the second leaf-sheath (△) is indicated as % increase of control length, respectively. Note: 1, Waito-C (*dwarf*); 2, Tanginbozu (*dwarf*); 3, Daikoku 1 (*dwarf*); 4, Bungetsu-to (*dwarf*); 5, Boshi-to (*Indica*).

The Effects of GA on the Elongation of the Second Internode

The response of the second internode was shown in table 1. The varieties are classified into four groups according to the degree of elongation. The ordinary Japonica varieties were included in types II and III, in which the GA action on interno de growth appeared only in the dark and not in the light. In Indica rice (Boshi-to), GA induced elongation of the second internode even in the light.

TABLE 1. *Growth Response of Second Internode of Rice Varieties to Gibberellic Acid and Light.* [a)]

Type of response	Treatment				Number of varieties observed	Typical variety
	Light		Dark			
	− GA	+ GA	− GA	+ GA		
I	−	+	++	+++	1	Boshi-to (*Indica*)
II	−	−	+	++	26	Sasanishiki (*normal*)
III	−	−	−	+	18	Waito-C (*dwarf*)
IV	−	−	−	−	1	Daikoku 1. (*dwarf*)

a) Degree of elongation is indicated as follows : −, invisible ; +, visible ; ++, considerable ; +++, marked growth. Experimental conditions are the same as in Fig.1.

Similar results were obtained by Takahashi* indicating that most Indica rice belonged to type I and most dwarf varieties to type IV.

It has been known that the stem elongation is suppressed by light and promoted by the application of GA in most higher plants (1). Lockhart (4) demonstrated that the applied GA reversed light-induced inhibition of stem growth in peas. In others, however, the exogenous GA enhanced the growth even in the dark (5).

From the present results, it was concluded that the relationship between the effects of applied GA and light on the ordinary Japonica varieties varied with the plant organ, *i.e.*, the primary leaf and the second leaf-blade responded to GA about the same degree in the dark as in the light. However, the promoting effects of GA on the elongation of the second leaf-sheath was much greater in the light than in the dark. In the second internode GA action appeared only in the dark.

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