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Effect of High Temperature Pre-Treatment on Elongation of the Mesocotyl of Rice Seedlings

IV. Effect of Some Growth Substances on Mesocotyl Elongation

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Mesocotyl elongation of *japonica* type rice was stimulated by only *cis*-ABA and GA₃, while that of *indica* type rice was stimulated by *cis*-ABA, GA₃, IAA and kinetin, respectively. Mesocotyl elongation of the *japonica* type rice pre-treated at high temperature was likewise stimulated not only by *cis*-ABA and GA₃, but also kinetin and IAA. In *japonica* type rice, the stimulation of mesocotyl elongation by growth substances increased with lengthening the duration of high temperature treatment.

INTRODUCTION

Japonica and *indica* types of rice, *Oryza sativa* L., differ in many of their characteristics, including mesocotyl growth habits. The mesocotyl of the former does not usually grow more than 1. cm long even in total darkness, whereas that of the latter elongates 5 cm or more (Hamada, 1937).

Recently, it was revealed that the mesocotyl of *japonica* type rice pre-treated at high temperature grew to the same length as that of *indica* type rice (Ohta, 1969; Inouye *et al.*, 1970a; Inouye and Ito, 1970). On the other hand, it was reported that ABA stimulated the growth of mesocotyl to more than 2 cm in non-treated *japonica* type rice (Takahashi, 1972, 1973).

The data presented in this paper indicate that some growth substances also stimulate mesocotyl elongation of pre-treated *japonica* type and non-treated *indica* type rice.

MATERIALS AND METHODS

The materials used were two varieties of *japonica* type rice, Hoyoku and Koshijiwase, and two varieties of *indica* type rice, Hatishail and Pusur.

Unless otherwise stated, culture media, culture methods and the procedure for high temperature pre-treatment of *japonica* type rice seeds were the same as described in the previous paper (Inouye *et al.*, 1970 b).

In order to examine the effects of some growth substances on mesocotyl

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Abbreviations used are: GA₃, gibberellin A₃; IAA, indole-3-acetic acid; ABA, abscisic acid.

elongation, substances were added to the culture medium before autoclaving at 0.6 kg/cm² for 15 minutes. The concentration of each substance was chosen on the basis of preliminary experiments. After sowing, rice was grown in total darkness for 2-4 weeks.

For each rice type, both varieties gave the same results, so only data from varieties Hoyoku (*japonica* type rice) and Hatishail (*indica* type rice) will be presented in this paper. In all experiments, samples consisted of about 20 plants.

RESULTS AND DISCUSSION

Effect of culture temperature on mesocotyl elongation

Seeds of the *japonica* type rice, Hoyoku, were pre-treated at 40°C for 10 days. Seeds of non-treated and pre-treated Hoyoku, and of the *indica* type rice, Hatishail, were sown and then grown at 15°, 20°, 25°, 30° and 35°C in total darkness for 2-4 weeks.

Table 1. Effect of culture temperature on mesocotyl elongation in darkness."

Temperature (°C)	Hoyoku		Hatishail
	Non-treated control	High temperature pre-treated	
15			
20	2±0.6	13± 7.2	18± 2.2
	1±0.6	22±14.7	19± 8.4
25	1±0.5	31±13.5	22± 3.7
30	1±0.8	37±13.6	38±13.4
35	1±0.9	38±11.6	39±18.1

1) Length of mesocotyl in mm&standard error.

The results are presented in Table 1, and show that in *japonica* type rice pre-treated at high temperature, mesocotyl elongation was stimulated under all subsequent cultural conditions. In both *indica* type and pre-treated *japonica* type rices, mesocotyl length increased with rising temperature. At 30° and 35°C, mesocotyl length was the same in both *indica* type and pre-treated *japonica* type rices.

Effect of some growth substances on mesocotyl elongation

High temperature pre-treatment of *japonica* rice seeds was carried out at 40°C for 10 days. Seeds of non-treated and pre-treated *japonica* type, and of *indica* type rice were sown on culture media containing growth substances. Thereafter they were grown at 30°C in total darkness for 2 weeks.

The results are given in Table 2. Although mesocotyl elongation of the *indica* type rice was stimulated by cis-ABA, IAA, GA, and kinetin, respectively, that of non-treated *japonica* type rice was stimulated only by cis-ABA and GA,. Mesocotyl elongation of the *japonica* type rice pre-treated at high temperature, however, was stimulated not only by cis-ABA and GA, but also by

Table 2. Effect of some growth substances on mesocotyl elongation in darkness.¹⁾

Concentration (M)	Hoyoku		Hatishail
	Non-treated control	High temperature pre-treated	
0 (treated control)	1 ± 0.8	37 ± 13.6	38 ± 13.4
GA ₃ 2 × 10 ⁻⁴	7 ± 0.8	114 ± 19.4	94 ± 40.9
IAA 2 × 10 ⁻⁶	2 ± 1.3	55 ± 15.0	114 ± 57.0
Kinetin 2 × 10 ⁻⁶	2 ± 0.6	50 ± 18.0	65 ± 16.0
cis-ABA 2 × 10 ⁻⁶	27 ± 10.7	89 ± 29.3	186 ± 26.1
trans-ABA 2 × 10 ⁻⁶	1 ± 0.8	40 ± 18.2	38 ± 14.3

¹⁾ Length of mesocotyl in mm+ standard error.

kinetin and IAA. The stimulation by cis-ABA, IAA and kinetin was greater in *indica* than in *japonica* type rice, whereas the response to GA, was greater in the pre-treated *japonica* type rice (cf. *indica*). No stimulation of mesocotyl elongation by *trans*-ABA was observed in any of the rice types tested.

It has been revealed by Suge (1971, 1972) that ethylene markedly stimulated the growth of mesocotyl in both rices of *indica* type and pre-treated *japonica* type, but it only slightly increased the mesocotyl length in non-treated *japonica* type rice.

From these results, it may be assumed that the control of mesocotyl elongation in *japonica* type rice pre-treated at high temperature is similar to that in the *indica* type rice.

Interaction of high temperature pre-treatment and some growth substances on mesocotyl elongation in a *japonica* type rice

High temperature pre-treatment of seeds was carried out at 40°C for 0, 1,

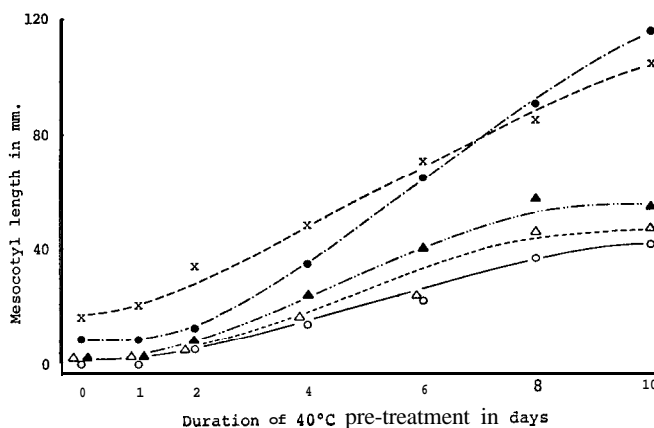


Fig. 1. Interaction of some growth substances with duration of high temperature pre-treatment on mesocotyl elongation in a *japonica* type rice, Hoyoku, in darkness. ●—●, GA, 2 × 10⁻⁴M; x—x, cis-ABA 2 × 10⁻⁶M; ▲—▲, kinetin 2 × 10⁻⁶M; △—△, IAA 2 × 10⁻⁶M; o—o, control.

2, 4, 6, 8 or 10 days. The seeds were sown on culture media containing growth substances and were grown at 30°C in total darkness for 2 weeks.

The results are summarised in Fig. 1, where mesocotyl elongation in heat-treated plants is more stimulated by addition of some growth substances. Plants pre-treated at 40°C for 2 days show already the promotion of mesocotyl elongation with GA₃, cis-ABA and kinetin, respectively, whereas for IAA this effect is only observed after 8 days pre-treatment. In samples pre-treated for 10 days, the combined effect of high temperature and growth substances is the greatest for GA₃ and cis-ABA, followed by kinetin and IAA.

These results indicate that some physiological change had already taken place, even in an embryo pre-treated at 40°C for only 2 days.

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