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Gibberellin Response of Dwarf Mutants of Rice*

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Summary

The GA response of fifteen dwarf mutants and one normal variety of rice were tested at seedling and adult stages.

There was a correlation between the GA response and the length of the second leaf sheath. Two dwarf mutants showed a very high response to GA; other mutants, however, showed a lower response than the normal variety.

Dwarf C showed a high response while Daikoku 1 showed a smaller response to GA at the adult stage.

From these results, it is suggested that the dwarfness is not only the result of a deficiency of GA but of other factors.

The GA response of these dwarf mutants should be tested further, using other kinds of GA.

Gibberellin (GA) plays an important role in elongation of plant parts. This has been shown originally in rice and later in other plants (1). The relative response to GA varies even among varieties of the same species; many tropical tall rice varieties showed a low GA response while short Japonica rice varieties showed a high response.** In many cases, GA seems to be the factor limiting the height of the plant. Certain dwarf mutants, however, have been shown to have a lower response than normal varieties (2, 3).

To certify these findings, the experiment was initiated by using some mutants of rice.

Materials and Methods

Experiment 1. Fifteen dwarf mutants and one normal variety shown in Table 1 were used in this experiment.

GA response of seedlings was tested by using almost the same method as

* A portion of the data was collected at The International Rice Research Institute, Los Baños, Laguna, Philippines.

** Harada, J. and Vergara, B.S. Unpublished data.

Murakami's for GA bioassay (4). The seeds were sterilized with 0.1 per cent $HgCl_2$ solution for 30 minutes and then washed with tap water. They were placed in petri-dishes with wet filter paper and then kept in the dark at 30°C for two days. The uniform germinated seeds were selected and 5 seeds were placed in each vial (25 mm×100 mm). Each vial contained 0.5 ml of the GA solution.*** The

TABLE 1. *List of Dwarf Mutants Used in This Experiment.*

No.	Variety	Seed source
1	Daikoku (d_1)	Faculty of Agriculture, Hokkaido University, Sapporo, Japan
2	Ebisu (d_2)	
3	Bungetsu-Waito ($d_3d_4d_5$)	
4	Heiei-Daikoku (d_7)	
5	Norin 28 Dwarf (d_8)	
6	Daikoku-Ebisu-mochi (d_1d_7)	
7	Ogi-mochi (d_2d_6)	
8	Ebisu-type Heiei-Daikoku (d_6d_7)	
9	Daikoku 1	Faculty of Agriculture, Tohoku University, Sendai, Japan
10	Daikoku 5	
11	Dwarf C	Tohoku National Agricultural Exp. Sta. Omagari, Japan
12	Kotake-Tamanishiki	National Institute of Agricultural Sciences, Hiratsuka, Japan
13	Murasaki-Daikoku	
14	Murasaki-Dwarf type-mochi	Faculty of Agriculture, Kyoto University, Kyoto, Japan
15	Tankan-Shirazasa	Faculty of Agriculture, Kyushu University, Fukuoka, Japan
16	Fujisaka 5 (Normal)	The International Rice Research Institute, Philippines (Acc. No. 244)

vials were covered with a plastic film and then placed in a growth chamber having a temperature of 30°C and a light intensity of 9000 lux at plant level. Three days later, 0.5 ml distilled water per vial was added and the measurements were made after another three days; or eight days after soaking. Distilled water was used for the control and each treatment was replicated. The length of the second leaf sheath was measured and the response to GA was expressed as follows:

treatment/control×100=GA response

Experiment 2. Three varieties were used in this experiment. Dwarf C and Daikoku 1 are the dwarf mutants and Fujisaka 5 is the normal variety.

The seeds were sown on June 3, 1967 and four plants per pot were transplanted on June 15 in porcelain pots containing 4 liters of culture solution. Nutrient levels were 40 ppm N (as NH_4NO_3), 10 ppm P (as NaH_2PO_4), 40 ppm K (as K_2SO_4), 2 ppm Fe (as Fe-citrate) and 0.5 ppm Mn (as $MnCl_2$). Calcium and magnesium salts were not added since the tap water used as water source contained a high level of these salts. The culture solution was renewed twice a week during this

*** Gibberellin was kindly supplied by Kyowa Hakko Kogyo Co. Ltd., Tokyo, which contained at least 93% pure GA_3.

experiment. GA*** was mixed into the culture solution, giving a final concentration of 0.1 and 1 ppm, twice a week starting from the 10th leaf (July 3) to flowering (August 11). Each treatment was duplicated. Plants were harvested on August 29 and the plant height, tiller number, length of flag leaf and length of panicle and internodes were measured.

Results and Discussion

Experiment 1. Fig. 1 shows the range of response to GA of several dwarf mutants. There is a correlation between the length of the second leaf sheath and its response

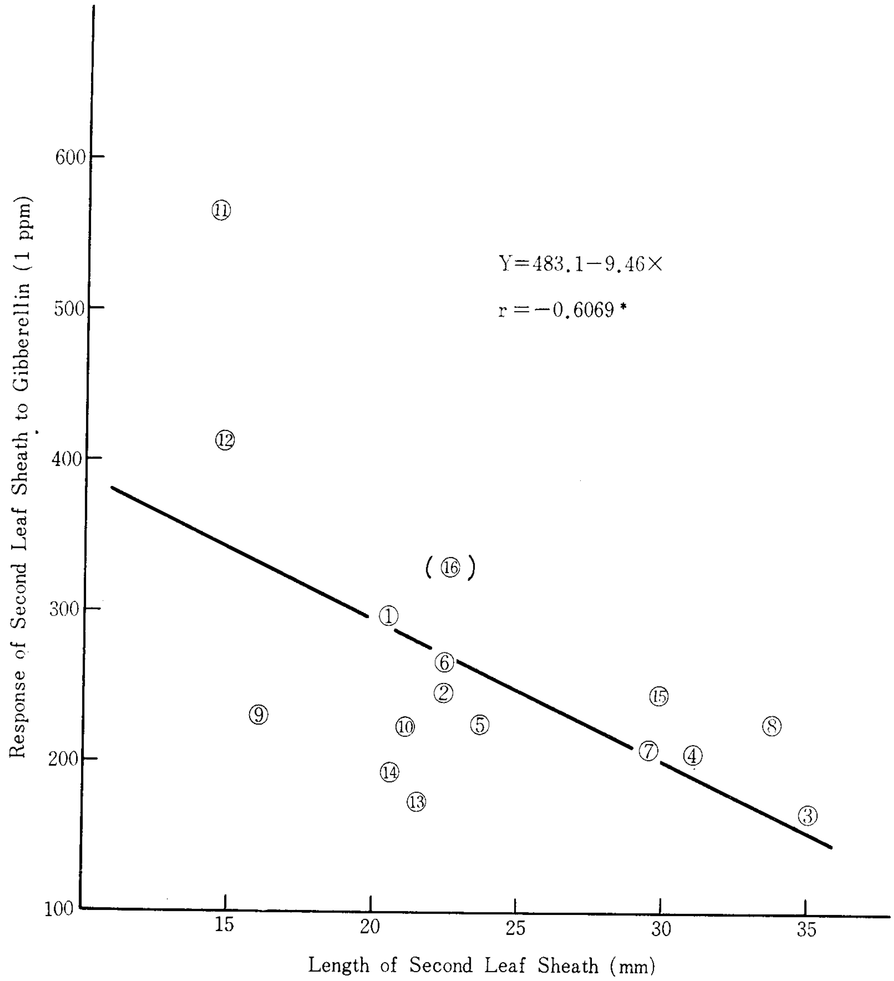

FIG. 1. The relation between the GA response and the length of the 2nd leaf sheath of several dwarf mutants. The numbering of variety corresponds to the one used in Table 1.

to GA; varieties having a short leaf sheath showed a high response to GA as did the normal varieties.** Dwarf C and Kotake-Tamanishiki gave an extremely high response to GA; Daikoku 1, however, showed a very low response in spite of having a short leaf sheath. Other dwarf mutants tested showed a low response compared to Fujisaka 5, a normal variety, although many dwarf plants have been

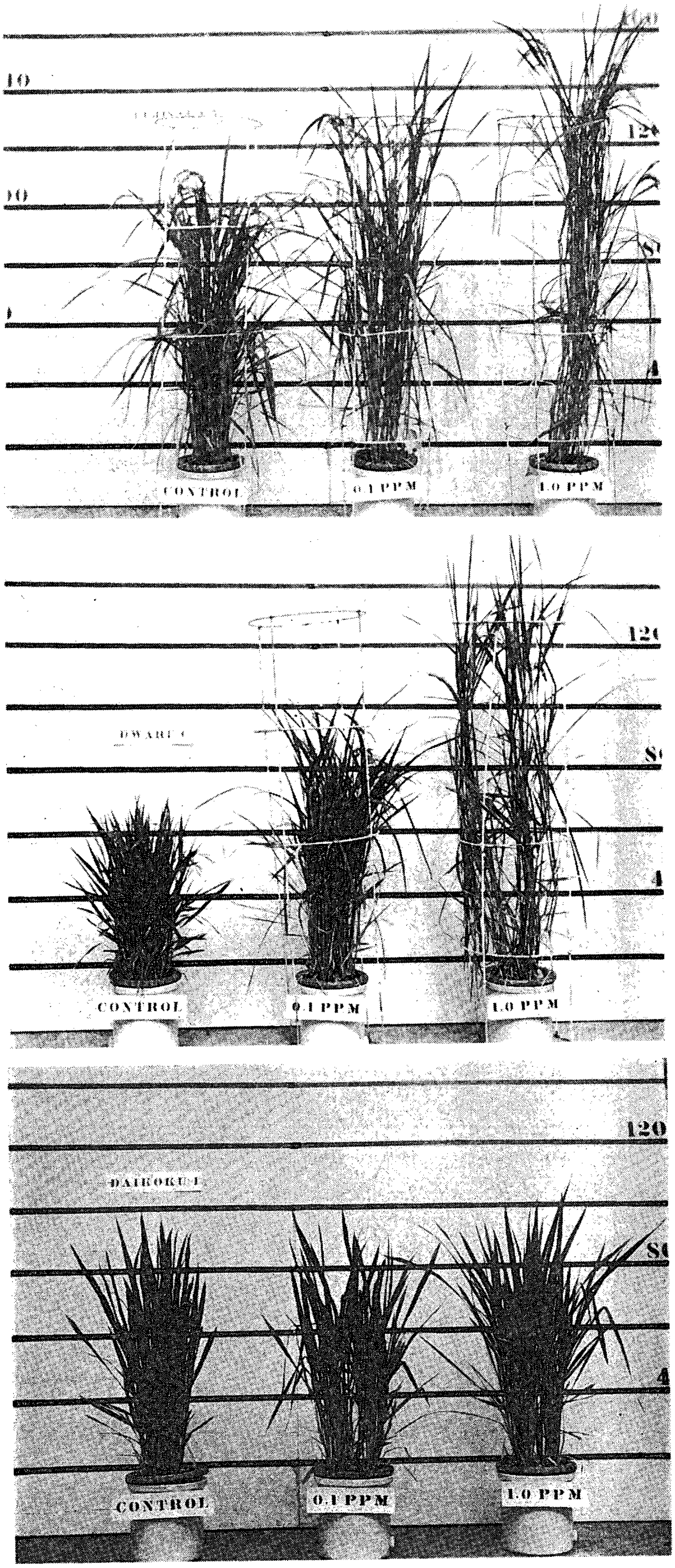

FIG. 2. Response of Fujisaka 5, Dwarf C and Daikoku 1 to 0.1 and 1 ppm gibberellin.

shown to have a high GA response (5, 6).

Experiment 2. The differences in the response of dwarf mutants to GA are also shown at a later stage; Figs. 2 and 3 show the response of the three varieties to applied GA. Comparatively, Dwarf C showed the largest response; Daikoku 1, however, gave a smaller response.

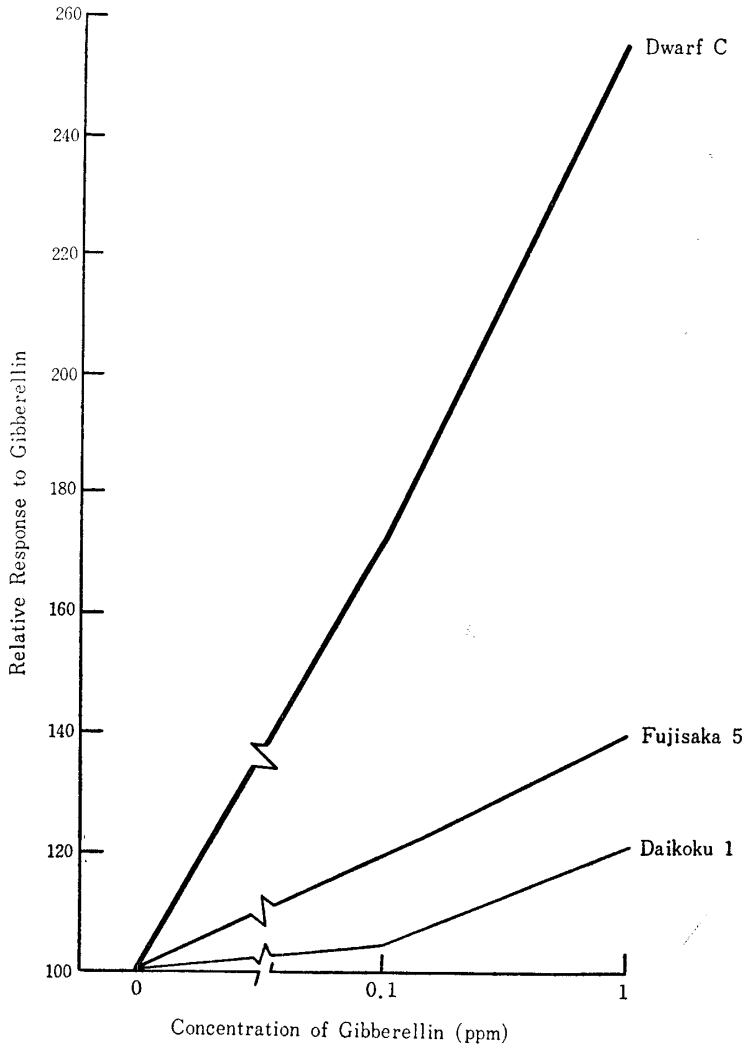

FIG. 3. Response of the culm to gibberellin using Fujisaka 5, Dwarf C and Daikoku 1.

A more detailed analysis of the response is shown in Fig. 4 and Table 2: plant height increased with the application of GA, and the increase in height was greater in the higher concentration; it is also reflected in the length of the culm. A longer culm was the result of longer internodes and the number of elongated internodes (Fig. 4). In all cases, the lower internodes (V, VI) responded more to GA than the upper internodes (I, II).

Table 2 also shows a reduction in number of tillers with GA treatment. The change in the length of the blade and sheath varied according to the variety and

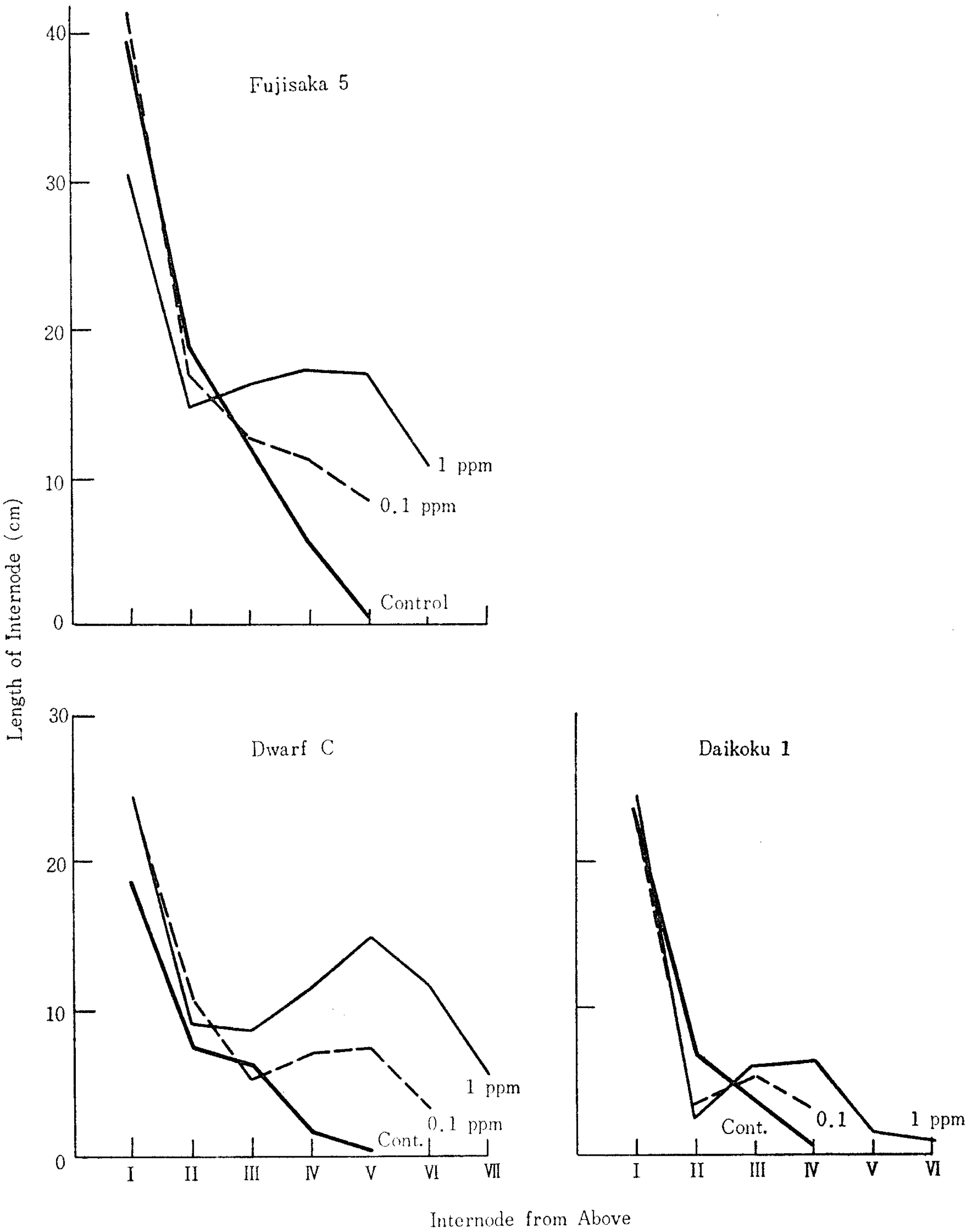

FIG. 4. Effect of gibberellin treatment on the length of the internodes of Fujisaka 5, Dwarf C and Daikoku 1.

GA concentration. The dry weight of the straw increased with the GA application in all varieties; the panicle weight of Dwarf C, however, greatly increased although it decreased in others. This panicle weight increase in Dwarf C may have been due to the great increase of the leaf area, which produced more dry matter. These results have been reported before (7, 8, 9).

From the experimental data which showed some dwarf mutants giving a lower response to the GA than the normal variety, it may be concluded that dwarfness is not always the result of a deficiency of GA-like substances but of other essential

TABLE 2. *Morphological Changes in the Plants Treated with Gibberellin.*

Variety	Conc. of gibberellin (*ppm*)	Plant height (*cm*)	No. of tillers	Length of flag leaf* (*cm*) Blade	Sheath	Dry weight (g/plant) panicle	straw	root	Length of panicle (*cm*)	Length of culm (*cm*)	No. of elongated internodes
Fujisaka 5	0	110.7	12.1	38.4	33.6	17.3	15.5	2.1	19.3	76.3	4.8
	0.1	133.4	7.3	45.2	37.1	13.7	15.6	1.3	20.9	91.1	5.0
	1	149.3	4.3	36.3	31.9	10.8	16.1	1.3	18.1	106.8	5.9
Dwarf C	0	54.6	14.0	20.1	16.5	6.4	7.9	0.7	14.4	33.8	4.4
	0.1	95.8	11.0	27.4	21.0	9.7	10.1	1.1	15.5	58.2	5.8
	1	142.1	6.5	40.4	26.1	10.3	14.4	1.0	15.2	86.0	6.6
Daikoku 1	0	71.9	6.6	35.4	23.6	4.1	11.1	1.2	13.4	33.9	3.1
	0.1	71.3	4.6	33.6	24.1	2.9	11.2	1.0	13.4	35.4	3.7
	1	82.8	3.9	37.1	22.7	2.8	15.5	1.2	13.4	40.8	4.6

* Flag leaf is 13th—15th leaf in all varieties.

factors.

It has been reported, however, that the activity of each gibberellin (A_1-A_9) varied among the species used for a bioassay. For example, GA_9 is inactive with dwarf pea stem growth but highly active in cucumber hypocotyl growth (10). Moreover, it has been reported in corn plants that there are some differences in the response to different kinds of GA even among dwarf mutants of the same species (10). Although Murakami reported recently that there were no big varietal differences of response to GA_1-GA_5 among four rice dwarf mutants tested (11), the GA response of dwarf mutants should be tested further, using other kinds of GA.

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References

1) Stowe, B.B. and Yamaki, T., *Science*, **127**, 807 (1959)
2) Kamata, K. and Kishimoto, O., *Jap. J. Breed.*, **10**, 204 (1960) (in Japanese)
3) Nagamatsu, T., Omura, T. and Tsuzuki, E., *Jap. J. Breed.*, **14**, 199 (1964) (in Japanese)
4) Murakami, Y., *Bot. Mag. Tokyo*, **70**, 376 (1957)
5) Brian, P.W. and Hemming, H.G., *Physiol. Plant.*, **8**, 669 (1955)
6) Phinney, B.O., *Proc. Natl. Acad. Sci.*, **42**, 185 (1956)
7) Hayashi, T. and Murakami, Y., *Bull. Natl. Inst. Agr. Sci.*, **D 7**, 159 (1958) (in Japanese, with English summary)
8) Ishizuka, Y. and Hirose, A., *J. Sci. Soil Manure, Japan*, **32**, 191 (1961) (in Japanese)
9) Shimizu, M., *Proc. Crop. Sci. Soc. Japan*, **33**, 379 (1965) (in Japanese, with English summary)
10) Brian, P.W., Hemming, H.G. and Lowe, D., *Nature*, **193**, 946 (1962)
11) Murakami, Y., *Bot. Mag. Tokyo*, **81**, 33 (1968)