A PRELIMINARY NOTE ON THE PHOTOSYNTHETIC RATE OF I-GEO-GEN LEAF IN RELATION TO THE RED DISCOLORATION UNDER LOW TEMPERATURE[1]

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Introduction

In Taiwan, one of the interests of rice workers is the difference in the yielding ability between the high yielding Ponlai varieties and the high yielding dwarf *indica* varieties. The dwarf *indicas* generally exhibit higher yield than the high yielding Ponlais (Chiu et al. 1965, Huang et al. 1966, Chiu et al. 1970 and Chiu 1971). However, this trend is inconsistent or sometimes reversed in the second crop in northern Taiwan.

The yield of I-geo-gen, a high yielding dwarf *indica*, was comparable with or lower than that of Taipei 309, a high yielding Ponlai, if it was transplanted later than August 5 in the 2nd crop or earlier than March 13 in the 1st crop (Taipei DAIS, 1967). This relatively low yield of I-geo-gen transplanted late in the 2nd crop, was probably due to the low temperature in the later growth stages (Huang 1970).

The higher yielding ability of the dwarf *indicas* compared with Ponlais is obviously due to the short stature which enable them to keep free from lodging on heavily fertilized soil, the high tillering ability and also the superior light receiving display of leaves and stems (Lian et al. 1970, Huang 1970). However, quick leaf senescence is considered to be a defect of dwarf *indicas*. In these varieties red discoloration of leaves takes place frequently when temperature is low and also when nitrogen supply is low (Huang 1970). The red discoloration under low temperature may be responsible for the low yield under low temperature.

The purpose of this report is to present a preliminary experimental evidence to show that the red discoloration of leaves is related to low temperature and the photosynthetic rate and the grain yield is decreased by the discoloration.

Materials and Methods

Hsin-chu-I-geo-gen (新竹矮脚尖) and Yūkara were used in this study. The former is a dwarf *indica* cultivated in northern Taiwan, and the latter is a *japonica* in Hokkaido, Japan.

On June 26, 1970, three seedings were transplanted to each pot in one hill and grown in a greenhouse at Hokkaido University. Each pot contained 3 kg of soil applied with 1 g each of N, P_2O_5 and K_2O. Four pots were made for each variety. The air temperature

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in the greenhouse was in the range of 25–40°C.

On August 3, at about maximum tiller number stage, four pots of each variety were divided into two groups. One group was kept in the greenhouse continuously and the other was transferred to another greenhouse, where the air temperature was kept in the range of 13–20°C (minimum and maximum). These pots were returned to the original greenhouse on August 14, after elevenday treat-ments. Then, the apparent photosynthetic rate of the intact leaves at specific positions was measured by a Hitachi-Horiba Infrared Gas Analyzer under 80 Klux at the air temperature of 27.5°C on August 15 and again on August 25.

The I-geo-gen plants were grown until maturity and the yields were recorded.

Results and Discussions

Significant red discoloration of leaves was observed in I-geo-gen after the low temperature treatment, whereas there was no such phenomenon in Yūkara. Slight wilting was also observed on the tips of I-geo-gen leaves during mid-day.

The apparent photosynthetic rate of leaves of I-geo-gen was decreased by the low temperature treatment, while that of Yūkara was not affected by the treatment (Table 1). In I-geo-gen, the effect of low temperature was holding on for a long period after the plants were transferred to normal temperature, although the leaves developed after the low temperature treatment showed a high rate (Table 2). In Yūkara the photosynthetic rate of the leaves subjected to low temperature was higher after the plants were transferred to the normal temperature.

In I-geo-gen the panicle weight decreased significantly due to the low temperature treatment, whereas the straw weight was not affected (Table 3). The decrease of panicle weight was not due to sterility but to the decrease of average weight per grain. Thus, it is apparent the decrease of the grain yield is the result of the decrease of photosynthetic rate of leaves.

These data presented above suggest that a low temperature causes red discoloration of leaves which accompanies a decline of photosynthetic rate in I-geo-gen. These phenomena was not observed in Yūkara which adapted to low temperature.

The practical significance of the above findings should be confirmed further by using dwarf *indicas* and ponlai *japonicas* so that it will throw light on the improvement of varieties in Taiwan.

Summary

To test if the red discoloration of leaves usually observed in I-geo-gen is related to low temperature and also if the photosynthetic rate and the grain yield are adversely affected by the discoloration, a pot experiment was conducted.

Rice varieties, I-geo-gen and Yūkara, were grown in a greenhouse at 25–40°C. At about maximum tillering stage, two temperature treatments, i.e., 13–20°C and 25–40°C (normal) were differentiated. These pots were returned to the normal temperature after eleven-day treatments. The apparent photosynthetic rate was then measured on certain intact leaves to see the effect of temperature treatment.

Significant red discoloration of leaves and also a decrease of apparent photosynthetic rate were observed in I-geo-gen after the low temperature treatment, whereas there was no such phenomenon in Yūkara.

It is suggested that low temperature causes more decrease in the grain yield due to the discoloration of leaves which accompanies a decrease of photosynthetic rate of leaves in *indicas* than *japonicas*.

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Table 1. Effect of temperature treatment on apparent photosynthetic rate of the active-center leaves of I-geo-gen and Yūkara measured on Aug. 15 (CO_2mg/100 cm^2/hr)

Variety / Treatment	I-geo-gen	Yūkara
Control	43.2	37.7
Low temperature	14.7	44.5

Table 2. Effect of temperature pretreatment on apparent photosynthetic rate of I-geo-gen and Yūkara measured on Aug. 25 (CO_2mg/100 cm^2/hr)

Variety / Position of leaf (from the top) / Treatment	I-geo-gen			Yukara
	1st*	2nd**	3rd	2nd**
Control	25.3±3.8	28.1±1.0	20.9	21.3
Low temperature	32.3±7.5	19.4±5.3	10.2	33.2

* The 1st leaf was developed after Aug. 15

** The 2nd leaf corresponds to the active center leaf measured on Aug. 15.

Table 3. Yield of I-geo-gen treated with different temperature during maximum tillering stage (g/pot)

Treatment	Panicle	Straw	Total
Control	55.8±0.8	66.3±1.2	122.1±2.0
Low temperature	37.3±3.6	59.4±3.4	96.7±7.0

低温與矮脚尖葉片之紅化及其對光合成速率之影響——預報

連　深

爲探討矮脚尖水稻常見之葉片紅化現象，是否與低溫有關，及此種紅化是否對光合成速率和稻谷收量有不良影響，乃舉辦盆栽試驗。

試驗主要係在25～40°C之玻璃室內進行。供試品種爲本省北部之矮脚尖和日本北海道之 Yūkara。前者屬印度型而後者則屬日本型。

當水稻大約達最高分蘖期時，各品種水稻之半數盆栽（二重覆）則被移置於 13～20°C 玻璃室，而另半數盆栽則繼續放置於 25～40°C 玻璃室。被放置於低溫玻璃室之水稻經過11天後再恢復移置於 25～40°C 玻璃室，隨後則測定各盆水稻中若干特定位置之葉片光合成速率，以觀察溫度處理對光合成速率之影響。

矮脚尖經過低溫處理後其葉片有顯著紅化現象，其光合成速率亦顯著低落，而 Yūkara 卻無。矮脚尖經過低溫處理者其平均粒重亦較對照處理（即無經低溫處理者）顯著低減。

由本試驗結果推測矮脚尖或一般印度型品種葉片之紅化，可能和低溫有關，而此種葉片之紅化將隨伴光合成速率之低下而影響稻谷收量。