THE TRANSFER OF A GENE FOR GLUTINOUS ENDOSPERM TO ORYZA GLABERRIMA STEUD. FROM A JAPONICA VARIETY OF O. SATIVA L.

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SUMMARY

In common rice, Oryza sativa L. (n = 12), the gene Am for 'non-glutinous' is dominant over the gene am for 'glutinous'. In African rice, O. glaberrima STEUD. (n = 12), no spontaneous glutinous strain has been found, but recently a glutinous strain of glaberrima was induced by EMS-treatment.

The interspecific cytoplasm substitution line with sativa cytoplasm and glaberrima nucleus is male sterile. It has been confirmed that the complete restoration of pollen fertility in this male sterile line is attributed to a single dominant nuclear gene Rf. Trial to transfer gene am from sativa to glaberrima was commenced with backcrosses of the F1 hybrid (glutinous sativa cv. Iwai-mochi 5 × glaberrima 5) to glaberrima type plants of the substitution line homozygous for RF, using the latter as the pollen parent. At the B1 step, highly fertile glaberrima type Am/am plants were obtained. Thereafter plants of this type were backcrossed to normal glaberrima as the recurrent pollen parent to complete the nuclear substitution. It was confirmed that the EMS-induced glutinous character of glaberrima was a monogenic recessive and that the same gene controls the expression of glutinous character in the different rice species, sativa and glaberrima.

INTRODUCTION

On the texture of their endosperm, varieties of Oryza sativa, Zea mays, Hordeum vulgare, Sorghum bicolor and Setaria italica have been divided into two main groups, non-glutinous and glutinous. The carbohydrate reserve material in the endosperm and pollen of the glutinous varieties gives a reddish-brown reaction to the iodine reagent instead of the normal blue reaction of the non-glutinous varieties. The starch in the endosperm and pollen grains of the non-glutinous varieties is composed of amylose and amylopectin; that of glutinous ones is virtually 100% amylopectin.

Genetical analyses of the hybrids between the non-glutinous and glutinous varieties indicate that the hybrids show a single Mendelian segregation. When a non-glutinous pollen grain is successful in fertilizing, the endosperm of the resulting seed is non-glutinous. This fact directly indicates that the gene for 'non-glutinous' is an amylose gene and dominant, and that the gene for 'glutinous' is a recessive one, which does not produce amylose; therefore it may be called amyloseless. Because of the chemical and genetical reasons mentioned, it is proposed that the gene which controls the production of amylose be designated Am. With this nomenclature, the recessive glutinous factor must be am (KIHARA, 1979). Although the gene symbols Wx or Gl and wx or gl
have as a rule been used by rice geneticists for ‘non-glutinous’ and ‘glutinous’, this paper uses \textit{Am} and \textit{am}.

\textit{Oryza sativa} (common rice) is cultivated throughout the rice-growing areas of the world. In Asia glutinous rice is usually steamed and pounded into cake. Glutinousness is one of the important agronomic characters of Asian rice varieties.

\textit{O. glaberrima} (African rice) is limited mainly to Tropical West Africa. All \textit{glaberrima} strains so far examined were non-glutinous, but a glutinous mutant of \textit{glaberrima} was induced by EMS-treatment at the National Institute of Genetics, Japan (Sano, 1977). \textit{Sativa} and \textit{glaberrima} have the same number of chromosomes (\(n = 12\)), and the interspecific hybrid shows no disturbance in chromosome pairing (Morinaga & Kuriyama, 1957; Nezu et al., 1960). The \(F_1\) plants are highly pollen sterile, but have embryo sac fertility. Interspecific cytoplasm substitution lines combining the cytoplasm of japonica varieties of \textit{sativa} and the \textit{glaberrima} nucleus were bred by means of repeated backcrossing Yabuno, 1977). These substitution lines were male sterile. It was elucidated that a single dominant nuclear gene, designated as \textit{Rfj}, was responsible for the full restoration of pollen fertility in these male sterile lines (Yabuno, 1976, 1977).

In 1974 I started with the transfer of the gene \textit{am} of a japonica variety, Iwai-mochi, to a \textit{glaberrima} strain, W0440, using the interspecific cytoplasm substitution line that had the fertility-restoring gene \textit{Rfj} in homozygous condition. The result is described in this paper. The genetic relation between the gene \textit{am} of \textit{sativa} and the EMS-induced glutinous gene of \textit{glaberrima} is also referred in this article.

**MATERIALS AND METHODS**

The following materials were used:

1) A glutinous japonica variety, Iwai-mochi : the donor of the gene \textit{am}, which is in linkage group I in \textit{sativa} (Nagao & Takahashi, 1963).

2) A \textit{glaberrima} strain, W0440 : the recipient of gene \textit{am} from Iwai-mochi.

3) An EMS-induced glutinous mutant of \textit{glaberrima} : this mutant was found in the \textit{glaberrima} strain GMS with colourless pericarp (Sano, 1977). Its fertility is normal. The EMS-induced glutinous gene is tentatively designated by the gene symbol \textit{amg} in this paper. With this symbol, the non-glutinous factor in \textit{glaberrima} should be \textit{Am}.

4) The interspecific cytoplasm substitution line (j)-gl, \textit{Rfj} \textit{Rfj} having the japonica variety Akebono cytoplasm, the \textit{glaberrima} W0440 nucleus and the fertility-restoring gene \textit{Rfj} in homozygous condition. This line derives from a selfed plant heterozygous for \textit{Rfj} (ID. M. F.) and has been maintained by selfing. The progeny could not be morphologically distinguished from a normal \textit{glaberrima} strain and the nuclear substitution in the progeny was supposedly accomplished. But its anther dehiscence was unstable owing to the japonica cytoplasm (Yabuno, 1977).

Plants were grown in pots saturated with water in a greenhouse under natural conditions. In order to examine pollen fertility and to determine the iodine reaction of starch, pollen grains and matured kernels were stained with a KI-I\(_2\) solution.