韓作誌(Korean J. Crop Sci.) 32(4) : 462~465

Pyramiding Resistance Genes to Leaf Blast in Rice through F_1 Hybrid

Hak Soo Suh,* Mun Hue Heu** and F.L. Nuque***

벼의 F_1 Hybrid를 이용한 稻熱病 抵抗性 遺傳子 集積

徐學洙* · 許文會** · 에프. 엘. 누퀘***

ABSTRACT

Three F_1 hybrids, Seokwang/Milyang 54, HR1619-6-2-1-2-2/Milyang 54 and 55061/IR19735-5-2-3-2-1, and their parents were inoculated with each of four individual blast races, IC-13, IH-1, IA-61 and IB-47, and the mixtures of two races, IC-13 and IH-1, IC-13 and IA-61, and IC-13 and IB-47, respectively.

The varietal reactions to the tested races showed that two parental varieties of each cross, Seokwang and Milyang 54, HR1619-6-2-1-2-2 and Milyang 54, and 55061 and IR19735-5-2-3-2-1 have different resistance gene(s) respectively.

The F_1 hybrids between two cultivars having different resistant genes were resistant to the mixture of two races of which one race was virulent to one parent and avirulent to the other parent respectively, while the parents of these F_1s were susceptible. This may suggest that the F_1 hybrids have wider spectrum resistance to leaf blast than their parents.

INTRODUCTION

Rice blast, caused by fungus *Pyricularia oryzae,* is one of the most significant disease in the rice growing countries, especially in the temperate region throughout the world. Varietal resistance was reported by many researchers (Niizeki, 1960, Atkins and Johnston, 1965, Tepora and Jennings, 1966, Hsieh and Chien, 1967, Padmanabhan *et al.,* 1973, and Kiyosawa, 1979). However, the resistance can be broken down due to the changes of the pathogen (Ou and Ayad, 1968, Quamaruzzaman and Ou, 1970, Crill and Khush, 1982). In order to cope with the pathogenic variability and breaking down of varietal resistance, race specific resistance genes were proposed to use for blast control (Crill *et al.,* 1981, Crill and Khush, 1982).

After successful development of F_1 hybrid rice in China (Lin and Yuan, 1980), many rice scientists have shown much interest on hybrid rice. Heterosis in yield, yield components, growth habit and some physiological characters was reported to be remarkable (Lin and Yuan, 1980, Virmani *et al.,* 1981).

Present experiment was conducted to prove the possibility of pyramiding resistance genes to leaf blast in rice through F_1 hybrids, because most of

*嶺南大學校 農畜産大學 (Coll. of Agr. & Animal Sci., Yeungnam Univ., Gyeongsan 632, Korea)
** 서울大學校 農科大學 (Dept. of Agronomy, Seoul National Univ. Suwon 170, Korea)
*** 國際米作研究所 (Plant Pathology Dept., IRRI, P.O. Box 933, Manila, Philippines) 〈'87. 12. 15 接受〉

the resistance genes to blast fungus in rice was reported to be dominant (Atkins and Johnston, 1965, Kiyosawa, 1979, Niizeki, 1960, Padmanabhan *et al.*, 1973, Tepora and Jennings, 1966).

MATERIALS AND METHODS

There F_1 hybrids Seokwang/Milyang 54, HR1619-6-2-1-2-2/Milyang 54 and 55061/IR19735-5-2-3-2-1 and their parents were tested to four blast races (isolates), IC-13 (750778), IH-1(43), IA-61 (IK81-3) and IB-47 (PO6-6), and the mixtures of two races IC-13 and IH-1, IC-13 and IA-61, and IC-13 and IB-47, respectively.

The rice seeds were sown in plastic pot (33 x 24 x 11 cm) containing field soil and 5g of ammonium sulfate. The rice seedlings of 2-3 leaf stage were inoculated with cultured inoculum by spray method. The inoculated seedlings were kept in the incubation chamber at 25°C with high humidity for 24 hours and then put in a humid chamber in the greenhouse for three days.

The fungal isolate stocks were cultured in prune agar medium containing 17g agar, 3 pieces dried prune, 1g yeast extract, 5g lactose in 1 liter distilled water. The plates were incubated in dark condition for four to five days at 30°C until mycelium is able to be observed, and subsequently transferred under a near-ultraviolet lamp for ten days to induce sporulation. The inoculum was prepared by flooding the cultures with distilled water and rubbing the culture surface with a brush. After counting the number of spores with hemacytometer, the concentration of spores was adjusted to 3-5 x 10^4 spores/ml.

One week after inoculation the reaction was scored using this scale; 0: no lesion, 1: small brown specks of pinhead size, 2: larger brown specks, 3: small roundish to slightly elongated, necrotic gray spots about 1-2 mm in diameter with brown margin, 4: a typical brown lesion, elliptical, 1-2 cm long, usually confined to the area of the two main veins. The reactions 0 to 2 were classified as resistant, 3 to 4 as susceptible.

RESULTS AND DISCUSSION

Table 1 shows the blast reactions of the three F_1 hybrids and their parents to the tested-fungus races. One parental cultivar Seokwang was susceptible to the race IH-1 but resistant to the race IC-13, and the other parent Milyang 54 was resistant to the race IH-1 but susceptible to the race IC-13. Thus, the rice cultivars Seokwang and Milyang 54 seemed to have different resistance genes to leaf blast. However, when these parental cultivars and the F_1 hybrid, Seokwang/Milyang 54 were inoculated with the mixture of the two races IH-1 and IC-13, the F_1 hybrid was resistant, while both of the parents were susceptible. (Fig. 1)

Another parental cultivar HR1619-6-2-1-2-2 was susceptible to the races IH-1 and IA-61 but resistant to the race IC-13, and Milyang 54 was resistant to the races IH-1 and IA-61 but susceptible to the race IC-13. The rice cultivars HR1619-6-2-1-2 and Milyang 54 appeared to have different resistance genes to leaf blast. The parental cultivars HR1619-6-2-1-2-2 and Milyang 54 were susceptible to the mixtures of the two races IH-1 and IC-13, and IA-61 and IC-13 repectively, but the F_1 hybrid

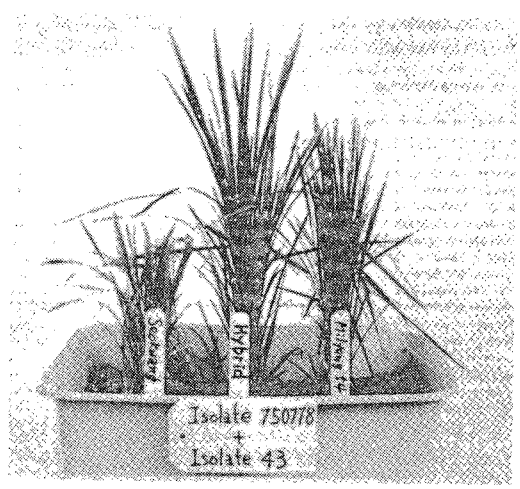

Fig. 1. Leaf blast reactions of rice cultivars Seokwang(left), Milyang 54(right) and F_1 hybrid Seokwang/Milyang 54 (middle) to the mixture of two fungus races IC-13 (isolate 750778) and IH-1 (isolate 43).

Table 1. Leaf blast reactions of three F_1 hybrids and their parents to four races and mixtures of two races of *Pyricularia oryzae* in rice.

Parents and hybrids	Race (isolate)				Mixture of races		
	IC-13 (750778)	IH-1 (43)	IA-61 (IK81-3)	IB-47 (PO6-6)	IC-13 and IH-1	IC-13 and IA-61	IC-13 and IB-47
Seokwang (P1)	R	S	–	–	S	–	–
Milyang 54 (P2)	S	R	–	–	S	–	–
F_1 (P1/P2)	R	R	–	–	R	–	–
HR1619-6-2-1-2-2(P3)	R	S	S	–	S	S	–
Milyang 54 (P4)	S	R	R	–	S	S	–
F_1 (P3/P4)	R	R	R	–	R	R	–
55061 (P5)	R	–	S	S	–	S	S
IR19735-5-2-3-2-1 (P6)	S	–	R	R	–	S	S
F_1 (P5/P6)	R	–	R	R	–	R	R

HR1619-6-2-1-2-2/Milyang 54 was resistant to the two kinds of mixture of races. (Table 1)

The parental cultivar 55061 was susceptible to the races IA-61 and IB-47 but resistant to the race IC-13 and the other parent IR19735-5-2-3-2-1 was resistant to the races IA-61 and IB-47 but susceptible to the race IC-13. These two rice cultivars also were proved to be controlled by the different blast resistance genes. The parents 55061 and IR19735-5-2-3-2-1 were susceptible to the mixtures of two races IA-61 and IC-13, and IB-47 and IC-13 respectively, but the F_1 hybrid 55061/IR19735-5-2-3-2-1 was resistant to these two kinds of race mixtures. (Fig. 2)

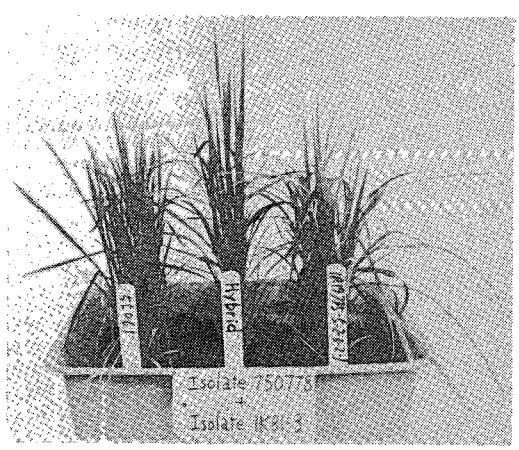

Fig. 2. Leaf blast reactions of rice cultivars 55061 (left), IR19735-5-2-3-2-1 (right) and the F_1 hybrid 55061/IR19735-5-2-3-2-1 (middle) to the mixture of two races IC-13 (isolate 750778) and IA-61 (isolate IK81-3).

From the reactions of the rice cultivars to blast races tested, the cultivars Seokwang and Milyang 54, HR1619-6-2-1-2-2 and Milyang 54, and 55061 and IR19735-5-2-3-2-1 appeared to be controlled by different blast resistance genes respectively. The F_1 hybrids from the rice cultivars having the different resistance genes seemed to have more resistance genes than their parents and showed wider spectrum resistance than their parental cultivars.

Most of the resistance genes to blast fungus in rice are reported to be controlled by dominant genes, 1, 4, 5, 7, 9, 11, therefore, the resistance genes to blast fungus are expected to be pyramided through F_1 hybrids. From the results, we may expect that we can stay ahead of pathogenic changes through changing of resistance genes in the F_1 hybrids with changing of combinations.

摘　　要

서광벼 / 밀양 54 호, HR 1619-6-2-1-2-2 / 밀양 54 호 및 55061 / IR 19735-5-2-3-2-1 등 3 개 組合의 F_1 잡종과 이들 兩親品種들의 幼苗를 각각 稻熱病 race IA-61, IB-47, IC-13 및 IH-1 등의 단독 race와 IC-13과 IA-61, IC-13과 IB-47 및 IC-13과 IH-1 등 2 race씩의 혼합inoculum으로 접종시켜 이들의 잎도열병 발병반

응을 검토하였다.

3개 組合의 兩親品種들은 단독 race에 대해서 서로 다른 반응을 보여 각각 서로 다른 抵抗性 유전자의 지배를 받는 것으로 나타났다. 이들 서로 다른 抵抗性 유전자를 가진 兩親品種들은 반응이 다른 2 race 씩의 혼합inoculum에 대해서 모두 이병성이었으나 이들간의 F_1 잡종은 모두 저항성이었다. 저항성 유전자가 서로 다른 兩親品種間의 F_1 잡종은 저항성 유전자의 集積效果로 因해 兩親보다 광범한 저항성을 나타내었다.

LITERATURE CITED

1. Atkins, J. G. and T. H. Johnston. 1965. Inheritance in rice of reaction to race 1 and 6 of *Pyricularia oryzae* Cav.. Phytopathology 55: 993-995.
2. Crill, P., Y. S. Ham and H. M. Beachell. 1981. The rice blast disease in Korea and its control with race prediction and gene rotation. Korean J. of Breeding 13:106-114.
3. Crill, J. P. and G. S. Khush. 1982. Effective and stable control of rice blast with monogenic resistance. In "Evolution of the gene rotation concept for rice blast control". Int. Rice Res. Inst., Los Banos, Philippines, pp. 87-102.
4. Hsieh, S. C. and C. C. Chien. 1967. Recent status of rice breeding for blast resistance in Taiwan with special regard to races of blast fungus. Proc. symp. on rice disease and their control by growing resistant varieties and other measures: pp 68-81. Tokyo, Agric. For. and Fish. Res. Council.
5. Kiyosawa, S. 1979. Possible application of gene for gene concept in blast resistance. ASPAC Food and Fertilizer Technology Center Technical Bull. No. 49. Taipei, Taiwan. 149.
6. Lin, S. C. and L. P. Yuan. 1980. Hybrid rice breeding in China. In "Innovative approaches to rice breeding" Int. Rice Res. Inst., Los Banos, Philippines, pp. 35-51.
7. Niizeki, H. 1960. Resistant gene for rice blast disease in variety Aichi Asahi. Agr. and Hort. 35:1321-1322. (In Japanese)
8. Ou, S. H. and M. R. Ayad. 1968. Pathogenic races of *Pyricularia oryzae* originating from single lesion and monoconidial cultures. Phytopathology 58:179-182.
9. Padmanabhan, S. Y., S. C. Mathur and P. K. Mishra. 1973. Inheritance of resistance of rice varieties to *Pyricularia oryzae*. Oryza 10:45-53.
10. Quamaruzzaman, M·D. and S. H. Ou. 1970. Monthly changes of pathogenic races of *Pyricularia oryzae* in a blast nursery. Phytopathology 60:1266-1269.
11. Tepora, J. N. and P. R. Jennings. 1966. Inheritance of resistance to *Pyricularia oryzae* (Phillippine races 15 and 20). Philippine Agriculturist 50:42-55.
12. Virmani, S. S., R. C. Chaudary and G. S. Khush. 1981. Current outlook on hybrid rice. Oryza 18:67-84.