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Breeding for partial resistance to rice blast caused by *Pyricularia oryzae* Cav. in Egypt

A.A. El-Hissewy*, A.A. El-Kady* and E.A.Salem**

*Rice Research Section, Field Crops Research Institute, A.R.C. Sakha (Egypt)

**Plant Pathology Research Institute A.R.C. Sakha, Kafr El-Sheikh (Egypt)

Abstract. Rice is among the important field crops in Egypt. It occupies about 0.5 million ha/year with 7.9 tons/ha as national average (Badawi, 1995). However, rice blast caused by *Pyricularia oryzae* Cav. is considered as the major constraint to rice production in Egypt. The losses due to it vary from moderate to severe according to the cultivated varieties and from one season to another. On the other hand, breeding for rice blast resistance in Egypt is characterized mainly by selection lines carrying single complete resistant genes; and, soon after this type of resistance was selected, the blast population could adapt to this type of resistance and it broke down. Accordingly, breeding for partial resistance to rice blast became a major concern in the Egyptian rice breeding program.

The present investigation was conducted at the Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt, to study the genetic behaviour of some partial resistance measurements, i.e. no. of type 4 lesion/plant, lesion length (mm), lesion size [length x width (mm)], and diseased leaf area (%). The segregating generations of the two rice crosses, Giza 175 (resistant)/Reiho (susceptible) and Gz 4120-205 (resistant) x Giza 176 (susceptible) were utilized during the 1990, 1991, and 1992 growing seasons.

The results showed that all measurements of partial resistance to rice blast behaved in a quantitative manner. Besides, they were mainly affected by an additive type of genetic variance. Moreover, the results revealed that heritability estimates, in the broad and narrow sense, were relatively high and moderate to low, respectively.

I – Introduction

Rice is among the most important field crops in Egypt. It occupies about 0.5 million ha/year with 7.9 tons/ha as a national average (Badawi, 1995). However, rice blast caused by *Pyricularia oryzae* Cav. is considered as the major constraint to Egypt's rice production. The losses due to rice blast vary from severe to moderate according to the cultivated variety and from one season to another. Effective chemical control is available. However, it causes environmental pollution and, in most cases, the pathogen become tolerant to chemicals. As a result, breeding for blast resistance became one of the principal objectives in the Egyptian rice breeding program. On the other hand, breeding for resistance is characterized mainly by selecting high levels of resistance based on major genes and, soon after this type of resistance was selected, the blast population could adapt to this type of resistance and it broke down. Accordingly, breeding for partial resistance to rice blast became a major concern in the breeding program. Partial resistance is a form of incomplete or quantitative resistance whereby a low disease severity is associated with a high infection type (Parleviet, 1979).

The objective of this investigation was to study the inheritance of some measurements of partial resistance to rice blast in two rice crosses involving resistant and susceptible varieties.

II – Materials and methods

The present investigation was conducted at the Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt, to study the genetic behaviour of some partial resistance measurements. These measurements were: no. of type 4 lesion/plant, lesion length (mm), lesion size [length x width (mm)], and diseased leaf area (%). Two crosses, namely: Cr1:Giza 175 (resistant)/Reiho (susceptible) and Cr 2:Gz 4120-205 (resistant)/Giza 176 (susceptible) were used in this study.

In the 1990 season, parents were crossed to produce the hybrid seeds which had been planted in the 1991 season together with their parents to produce hybrid seeds (by crossing parents again), Bc1 and Bc2 (by crossing parents x F1 plants), and F2 seeds (by selfing F1 plants). The main experiment was carried out in the 1992 season and it consisted of parents + F1 + F2 + Bc1 + Bc2 for each of studied crosses cross in an RCBD experiment with three replications. The entries were individually transplanted at 30 days after planting with 20 x 20 cm apart. All experiment conditions were managed to increase the chance of blast infection such as: late planting (June 15), high level of nitrogen (150 kg N/ha), border of highly susceptible varieties (Giza 159 + Sabeiny).

In addition, an artificial inoculation by spore suspension prepared from affected leaves was done 20 days after transplanting.

The biometrical model proposed by Mather and Jinks (1971) was used to estimate the genetic components for the studied characters. Heritability in its broad sense was estimated according to Power et al. (1950). Heritability in its narrow sense was estimated according to Warner (1952).

III – Results and discussion

1. Mode of inheritance for studied measurements of partial resistance

Figures 1,2,3 and 4 demonstrate the segregation pattern of the studied generations for the four characters in the two crosses: Cr1: Giza 175 (resistant)/Reiho (susceptible) and Cr2: Gz 4120-205 (resistant)/Giza 176 (susceptible). It is obvious that a wide range of variations was observed for all studied characters in the two crosses. The relative distributions for these crosses were fairly fitted a continuous distribution curve for no. of type 4 lesion/plant, and diseased leaf area (%) characters, while in case of lesion length (mm) character, and lesion size [length x width (mm)], the entire distribution exhibited a form of two peaked curves for one of the studied crosses. On the other hand, both parental types involved in the above mentioned crosses were covered by the two extremes of the distribution curves indicating the existence of transgressive segregation for all characters. The results concluded that these characters behaved as in a quantitative manner and this might be governed by polygenes. The results were in harmony with those reported by Higashi and Kushibuchi (1979), Li and Lin (1985) and El-Hissewy et al. (1992).

2. Genetic variance and heritability estimates for studied measurements of partial resistance

Table 1 shows the partitioning of the genetic variance into additive and dominance components for four studied characters of the two crosses. It is clear that the additive genetic variance was higher than the dominance one for all characters except for no. of type 4 lesion/plant where the dominance genetic variance was more than the additive variance in the two crosses. These findings indicated that the additive genetic variance has an important role in the inheritance of lesion length, lesion size and diseased leaf area. However, the dominance genetic variance was more important in case of no. of type 4 lesion/plant. Ezuka (1979) and Lin (1985) reported similar results, however El-Hissewy et al. (1992) found that the additive genetic variance was important for lesion length and diseased leaf area, the dominance was important for lesion length and both additive and dominance variances played equally for no. of type 4 lesion/plant.

Furthermore, heritability estimates in broad and narrow senses for the studied measurements of partial resistance in the two crosses were shown in Table 2. Moderate to high estimates of heritability in its broad sense were computed for the studied characters. It ranged between 0.502 (for no. of type 4 lesion/plant, in cross 2) and 0.873 (for lesion length, in cross 2). On the other hand, moderate to low estimates of heritability in the narrow sense were observed for all characters in both crosses. These estimates were minimized in case of no. of type 4 lesion/plant (0.383 and 0.433, in cross 2 and 1, respectively) and maximized for lesion length (0.716, in cross 2) and diseased leaf area (0.668, in cross 1). These results could lead to the fact that the effectiveness of any breeding program for the studied cha-

characters depends mainly on the character itself in one side and the cross in the other side. The same conclusion was reported by Higashi and Kushibuchi (1978), Ezuka (1979), Lin (1985) and El-Hissewy et al. (1992).

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Annexe

Table 1. Partitioning of genetic variance into additive and dominance components for four studied characters of the two studied crosses

Cross	Lesion length		Lesion size		No. type 4 lesion/plant		Diseased leaf area	
	1/2 D*	1/4H**	1/2 D*	1/4H**	1/2 D*	1/4H**	1/2 D*	1/4H**
Giza175/Reiho	0.771	0.184	1.556	0.547	0.658	0.783	0.943	0.642
Giza 177/Giza 176	0.932	0.216	0.973	0.487	0.566	0.883	0.765	0.558

* 1/2D: Additive genetic variance

** 1/4 H: Dominance genetic variance

Table 2. Heritability estimates in broad and narrow senses for the studied characters of the two studied crosses

Cross	Lesion length		Lesion size		No. type 4 lesion/plant		Diseased leaf area	
	h2 b*	h2 n**	h2 b*	h2 n**	h2 b*	h2 n**	h2 b*	h2 n**
Giza 175/Reiho	0.863	0.662	0.751	0.458	0.648	0.433	0.857	0.668
Giza 177/Giza 176	0.734	0.716	0.873	0.492	0.502	0.383	0.685	0.658

* h2 b: heritability in broad sense.

** h2 n: heritability in narrow sense.

Figure 1. Relative frequency distribution of lesion length (mm)

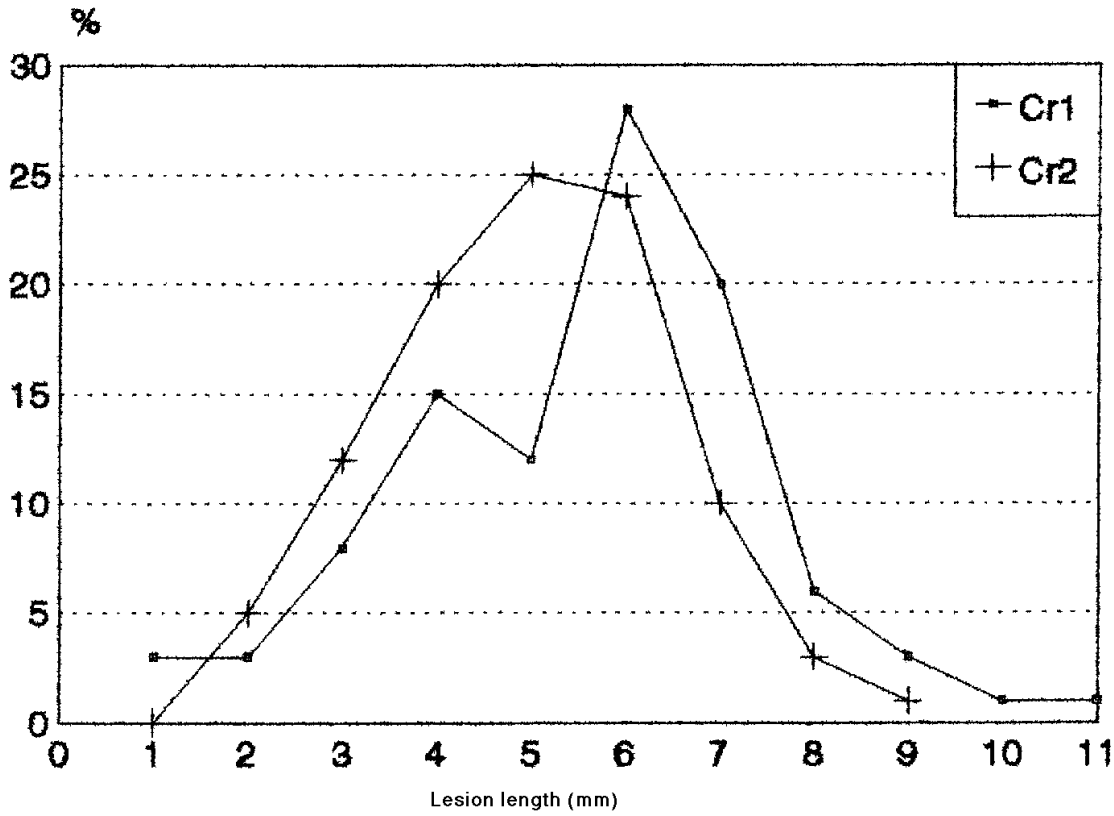


Figure 2. Relative frequency distribution of lesion size (mm²)

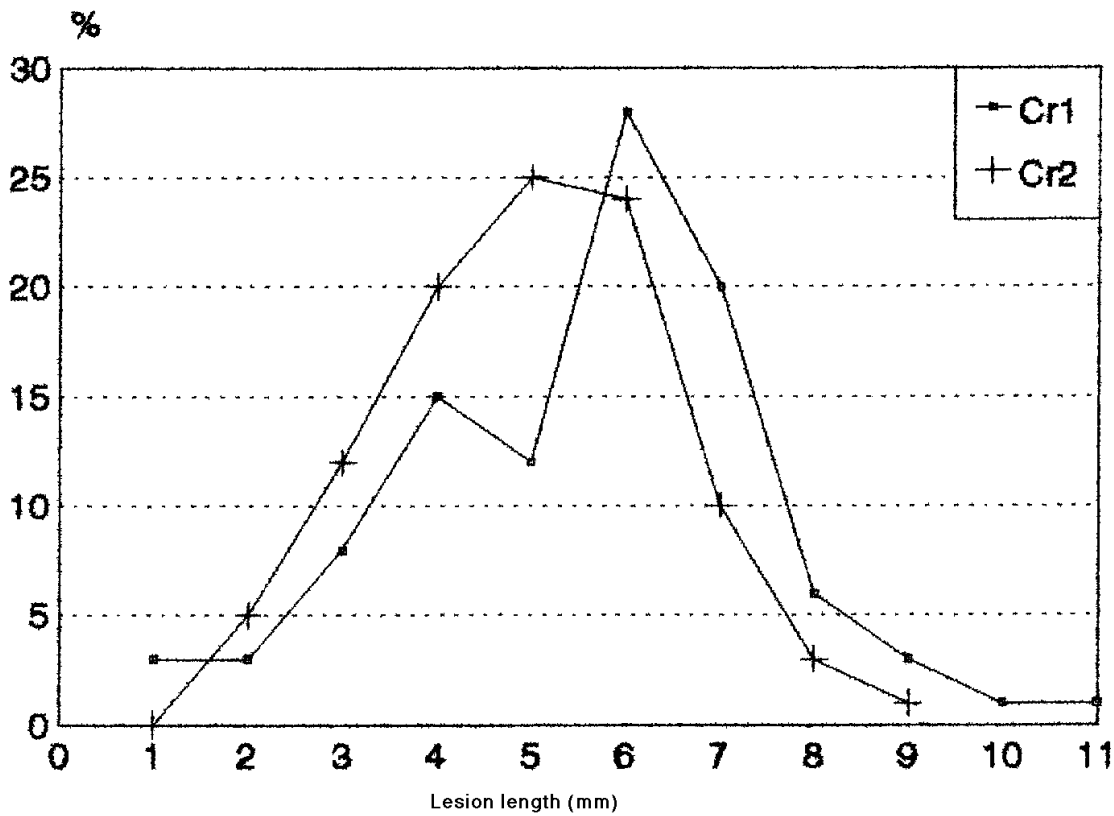


Figure 3. Relative frequency distribution of No. of type 4 lesion

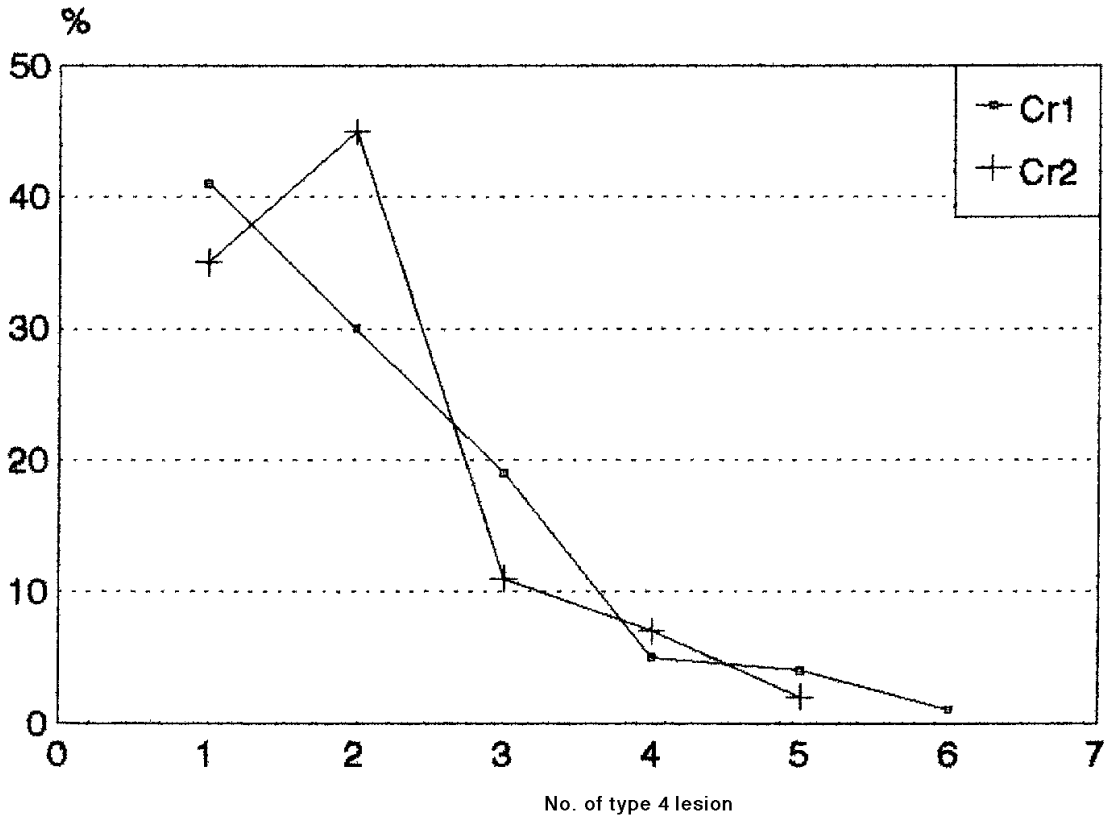


Figure 4. Relative frequency distribution of diseased leaf area (%)

