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Breeding for Rice Resistance to Stem Rot *(Sclerotium sp.)* in Mediterranean France

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In France stem rot (*Sclerotium sp.*) is an endemic disease affecting irrigated rice in the Mediterranean rice-growing area. The pathogen attacks, more or less early, the basic part of the rice plant under water level. The injuries are both the withering of the incidence of such attacks (lodging, plants senescence are mainly observed after the final drainage of the paddy field ; other characters like panicular fertility or processing yield levels can also be affected depending on the precocity of infestation. Generally low, the injuries level can be stronger according to specific climatic conditions (wet summer) and able to cause important yield of losses (till 20 q/ha) on susceptible varieties. So, the research of a good level of stem rot varietal resistance is an important breeding goal in order to improve production regularity. The stem rot strong attack of the 1992 cropping season offered the opportunity to evaluate, under natural infestation, the resistance level of some parents and of their progenies and to undertake a study of genetic determinism of the character.

I – Material and methods

All the observed progenies derive from crosses between *Japonica* type varieties and worked either by the conventional pedigree method (F) or by the doubled haploid method (HD).

The character of stem rot resistance/susceptibility has been noted according to plant senescence/non senescence observed at the physiological maturity stage, after the verification of effective stem rot damages on senescent plants. The observation concerned only progenies coming from crosses between parents showing a good or medium tolerance to stem borer because of the risk of confusion between stem rot and stem borer damages. On the other hand, the data noted on the conventional pedigree genotypes in our usual 25 cm x 10 cm planting (particularly proximity lodging) did not allow a correct evaluation of plant senescence origin. Lastly, only the crosses represented by a sufficient population of F3-HD2 lines or F4-HD3 families have been considered in the genetic determinism analysis.

It is necessary to precise that no particular selection for stem rot resistance has been done during the precedent cropping seasons. On the other hand, we will admit that stem rot resistance not linked with an undesirable character would be eliminated in F2-HD2 or F3.

II – Results

Table 1 reports the name of the crosses, the level of stem rot resistance of the parents, the generation of inbreeding during the 1992 cropping season, the observed and theoretical behaviour frequencies and the results of the X2 conformity test. All the observed frequencies can be explained by genetic systems involving two genes. Two types of control can be distanced :

1. Intervention of two linked genes

Progenies coming from some crosses between resistant and susceptible parents (Thaïbonnet x Miara, Deltaribe Y x Miara and probably for Cristalava x Miara) show similar ratios of resistant or susceptible lines or families. Theoretical frequencies have been calculated according to the segregation of gametes with linked genes derived from resistant (AAbb) and susceptible (aaBB) genotypes. The conformity between observed and theoretical frequencies is very good.

Data noted on Lido x Miara doubled Haploid lines can be explicated either by a four-independent genes or by a two-linked genes segregation. This last hypothesis is the most probable by comparison with the other results. It is possible to conclude that stem rot is controlled by two-linked genes separated by a distance of 8.3 cm, the homozygous double recessive genotype being resistant.

2. Intervention of two independent genes

The observed frequencies were in Arlésienne x Miara (with the hypothesis that resistance is controlled by the double recessive genotype), Delta x Miara and DLB x Miara. On the other hand, theses results show the genetic control diversity present in the considered parents ; indeed stem rot resistance can appear dominant (DLB x Miara) or recessive (Delta x Miara, Arlésienne x Miara).

III – Discussion

The analysis of stem rot resistance genetic control presented in this leaflet shows that few genes are involved in character determinism. It is possible to explain the observed frequencies by the segregation of the two independent linked genes. For each type of control, it seems in addition that the character of resistance can be attributed to various allelic combinations. These hypotheses have to be confirmed through laboratory tests with *Sclerotium sp*. artificial infestation. This method will allow more precise damage notations (according to the *Sclerotium sp*. development in rice stem) and therefore a better observation of the intermediate level of resistance/susceptibility than field observations which have to be done with less precision.

Practically, breeding to obtain stem rot resistant lines appears quite easy because, in the case of strong natural infestation, the reaction between host and pathogen is none or of all types at maturity stage. On the other hand, genetic *Japonica* varieties allow the crosses parents whatever their resistance level may be. Finally, there is every chance that the resistance will be durable because of the stem rot pressure irregularity and of the genetic diversity determining the resistance character.

The problem is more critical if the F1 hybrid rice is considered. Indeed, it has been observed, from some crosses between stem rot resistant and susceptible varieties that the F1 behaviour was intermediate. This intermediate resistance level can constitute an important constraint on F1 hybrid rice cropping in conditions of strong stem rot attack when panicular fertility level can be affected. For example, panicular fertility ratios noted on Thaïbonnet x Miara F1 scored 93.2% in 1989 (weak stem rot attack) versus 74.1% in 1992 (strong stem rot attack). This decrease in panicular fertility is the main factor accounting for a decrease of the F1 hybrid production between the two years. Consequently, in the framework of a F1 hybrid rice programme, among the characteristics having to be derived from the parents, it is absolutely necessary to consider the specific ability to give a stem rot resistance in F1.

Table 1. Behaviour of progenies coming from some intra *Japonica* crosses in relation to stem rot infestation

Linked genes hypothesis

Generation of inbreeding	Cross (stem rot parental resistance)	Number of lines/families	Progenies behaviour - Frequencies (%)						
			Observed			Theoretical			X2 test
			R	S	Mixed	R	S	Mixed	
F3	Thaïbonnet x Miara (RxS)	24	25.0	29.2	45.8	25.0	25.0	50.0	1.06
F4	Thaïbonnet x Miara (RxS)	21	28.6	23.8	47.6	25.0	25.0	50.0	0.69
	Deltaribe Y x Miara (RxS)	30	23.3	30.0	46.7	25.0	25.0	50.0	1.33
F5	Cristalava H1 x Miara (RxS)	107	30.4	39.3	44.6	–	–	–	–
HD 2	Lido x Miara (SxR)	161	8.3	91.7	–	–	–	–	–

Independant genes hypothesis

Generation of inbreeding	Cross (stem rot parental resistance)	Number of lines/families	Progenies behaviour - Frequencies (%)						
			Observed			Theoretical			X2 test
			R	S	M or I	R	S	M or I	
F4	Arlesienne x Miara (SxS)	25	12.0	52.0	36.0	6.3	56.3	37.4	5.67
HD 3	Delta x Miara (MSxS)	18	25.0	47.5	27.5	25.0	50.0	25.0	0.38
	DLB x Miara (RxS)	23	53.4	23.8	23.8	50.0	25.0	25.0	0.35

X2 0.05 = 5.99 for 2 d.f.

Guide * Generation of inbreeding – Fn : conventionnal pedigree method generation
HDn : doubled haploïd generation
* Varietal or progenies behaviour type – R : resistant ; S : susceptible ; Mixed or M : presence of resistant and susceptible lines in a family or/and resistant and susceptible plants in a line ; I : intermediate resistance.