Mycopath (2006), 4(2): 13-16

Screening of wheat plants of "Poros-monos" x "M30" for seedlings vs adult plant resistance against powdery mildew (*Erysiphe graminis DC. f. sp. tritici*)

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Abstract

In this experiment, F2- monosomic lines of wheat from a cross between Poros-monos and M30. were screened for resistance against powdery mildew. Nine monosomic lines- 1A, 1D, 2A, 2D, 3B, 4A, 4B, 5B, 7D have shown some resistance against powdery mildew, while five monosomic lines- 2B, 3D, 4D, 5D, 6A were found susceptibile against this disease. A high range of susceptibility was observed by the chromosome 7B. The chromosomes 2B, 4D, 5A and 6A have shown a wide range of resistance both at seedling as well as in adult stage. The resistant genes at seedling stage try to maintain their power of resistance even when they enter into the adult stage.

Key words: Monosomic lines, Poros, M30, Powdery mildew, *Blumeria graminis tritici, Erysiphe graminis tritici*.

Introduction

Breeding for resistance is an integrated process that requires development of suitable screening techniques, a search for sources of heritable resistance, and the transfer of resistance from related wild species (Knott and Dvorak, 1976, Stalker, 1980) to advanced breeding lines, which often requires a program of backcrossing. A major problem in resistance breeding is caused by genetic variations in pathogens 'overcoming' genetic resistance in the host (Van der Plank, 1984), especially when air-dispersed pathogens are involved. Moreover, environment, especially temperature, often modifies the interaction between host and pathogen. An understanding of the often complex relationships between host, pathogen and environment, therefore, holds the key to successful resistance breeding (Arnold *et al.*, 1976; Williams, 1989). Innes (1992) screened about 50 million live conidia of barley powdery mildew, but analysis of virulent mutants failed to confirm their mutational origin. In wheat powdery mildew caused by *Blumeria graminis*.(DC). Speer ssp *tritica* (=*Erysiphe graminis tritici)*. Simmonds (1991) reported four mutants for virulence; corresponding to three resistance genes simultaneously. Adult plant resistance of oat cultivar "Moldwyn" has been investigated very intensively. At the seedling stage the oat plants show moderate susceptibility towards powdery mildew (Jones and Hayes, 1971). In wheat, resistance of the variety "Diplomat" is brought about by genes located on 14 chromosomes (Chae and Fischbeck, 1979). On the other hands Ellingboe (1981) found that mildew resistance of wheat variety "Genesee" could be traced back to one dominant gene. Sperling (1985) analyzed the resistance of "M30" x "Strubes Dickkopf" at seedling stage inside the green house. She concluded that the resistance of wheat plant to powdery mildew is controlled by two independent dominant genes (15:1) both in adult as well as in seedling stage. Zedler (1990) reported a horizontal resistance in "M30" x "Carston v". Horizontal resistance in "M30" and susceptibility of "poros" against powdery mildew is also reported by Khan and Bluethner (1994).

The main objective of the project was to identify the chromosomes of "Poros-monos x M30" carrying resistance genes against powdery mildew at seedling as well as in adult stage and to compare and contrast their presence both at seedling as well as in adult stage.

Materials and Methods

Project was conducted at the Cytogenetics Laboratory, Plant Protection Department, Martin-Luther- University, Halle/Wittenberg, Federal Republic of Germany, during a short visit programme. Methodology of the project comprised of following techniques:

Inoculation

A wide range of techniques have been devised for studies on cereal powdery mildew, although primarily for elucidating host resistance of the gene-for-gene type. In this project 120 F2- seeds/lines

were sown in plastic trays inside the green house. Twelve days older seedlings were inoculated by shaking vigorously the diseased plants of variety "Strubes Dickkopf" over the seedlings (Hiura, 1978). For artificial infection the Race 2000 (Frauenstein *et al.*, 1983) was used as source of disease. Resistant seedlings were selected with the application of assessment scale 0-4 (Table 1).

Reading of Host-Pathogen Interaction

Gene-for-gene interactions among adult plants are recorded on the infection type scale starting from 0 to 9, where 0 is no visible fungal growth, and 9 is abundant growth and sporulation (Hiura, 1978), and interaction among young seedlings is made by scale 0 to 4, where 0 is a high percentage of resistance and 4 is 100 percent susceptibility. Data were taken by counting the number of spores on the third leaf of each plant in adult stage.

Results and Discussion

As a result of artificial spores inoculation, the genotypes under observation have responded in three different ways (Table 2). The first group being separated as a result of artificial inoculation includes all those monosomic lines which carry resistant genes against powdery mildew viz:: 1A, 1D, 2A, 2D, 3B, 4A, 4B, 5B, and 7D. The second group of plants is actually the combination of susceptible genotypes namely, 2B, 3D, 4D, 5D, and 6A. The third group includes only monosomic line 7B. In case of 7B 339 plants were tested against powdery mildew, which indicated 100 % susceptibility to this disease. This line has got 100% similarity with variety "Poros", which is greatly effected by powdery mildew.

In another experiment 140 "poros" plants were tested against this disease and all the plants exhibited a serious attack of powdery mildew, while the variety "M30" has shown a complete resistance against this disease. Similar type of results were reported by Sperling (1985). She crossed "M30" with "Strubus Dickkopf" and concluded that two independent dominant genes (Pm 2 and Pm 6) are responsible for the resistance inheritance. These findings are in close agreement to those reported by Khan (1991), who identified chromosomes 2B, 3D, 4D, 5A, 5D, 6A and 7A for carrying resistant genes and 1A, 2A, 3A, 4B, and 7D for genes susceptible to this disease. Jha (1969a and 1969b) examined the variety "Lerma Rajo" and concluded that resistant genes are located on chromosome 6B for seedling resistance. and on 2B, 3A, 3B, 4B and 5A for adult stage resistance. Schuster and Khan (1991) genetically analyzed two F2 -progenies at seedling stage, where 10 mildew resistant genes were identified. In Triticum boeoticum species the same mildew resistant genes were reported in adult plants.

Table 1: Infection grade assessment scale for powdery mildew at seedling stage (Nover, 1941).

Type-0	A high percentage of resistance, no symptoms visible
Type-1	Resistant, presence of necrotic or chlorotic symptoms
Type-2	Medium resistance, very little pustules present on leaves
Type-3	Partially susceptible, presence of pustules in large numbers
Type-4	Susceptible, spores building.

Table 2: Chi-Square Test for the estimation of segregation ratios of Poros-monos x M30 chromosomes against euploids control.

Monosomic Lines	No. of Plants	Resistance 1-4	:Susceptible 5-9	Chi-Sq. for 3:1
1A	320	211	109	6.52
1B	Absent	----	----	----
1D	328	227	101	1.59
2A	289	177	112	17.72
2B	276	223	53	9.89**
2D	348	254	94	0.07
3A	324	212	112	7.69
3B	336	229	107	2.91
3D	279	211	68	1.51
4A	340	260	80	2.90

4B	340	210	130	18.95
4D	290	269	21	60.40**
5A	337	268	69	8.71**
5B	343	260	83	2.07
5D	351	258	93	0.23
6A	346	294	52	27.62**
6B	Absent	----	----	------
6D	Absent	----	----	------
7A	282	192	90	2.53
7B	339	128	211	202.43
7D	330	252	78	2.68
Euploid	330	264	101	-----

* Positive significance = 5% X^2-Table = 3.84

Table 3: Comparison of critical chromosomes for Seedling vs adult stage resistance in a cross between "Poros-monos x M30"(Schmalz, 1989).

Chromosomes	1	2	3	4	5	6	7
	A B D	A B D	A B D	AB D	AB D	A B D	A B D
Plants							
Adult Stage	-	- +	-	- +	+	+	-
Seedling Stage	+ +	+ +	+	+ +	+		+
Test against 3:1							
Test against x total	-	- +	+	- +	+ - +	+	+

+ Resistant genes - Susceptible genes $\propto$**= 5%** x^2**- 3.**84

Table 3 reveals the results of an experiment in which four chromosomes with resistance against powdery mildew in adult stage were tested to confirm the presence of resistance even at seedling stage. The results indicated the confirmation of these four chromosome (2, 4, 5 and 6) as critical chromosomes against powdery mildew both at seedling as well as in adult stage. According to the theory of monosomic analysis these four chromosomes are considered to be critical chromosomes showing a positive response towards powdery mildew. These chromosomes are actually the carrier of genes showing a complete range of resistance against a serious disease of wheat crop. These observations agree with the findings of Sperling (1985), Jha (1969a and 1969b), Khan (1991) and Khan and Schuster (1991).

From these observations it was concluded that the adult plants carrying resistant genes against powdery mildew correspond to the chromosomes at seedling stage.

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