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F 1

AN EFFICIENT METHOD OF BREEDING WHEAT RESISTANT TO SEPTORIA TRITICI BLOTCH

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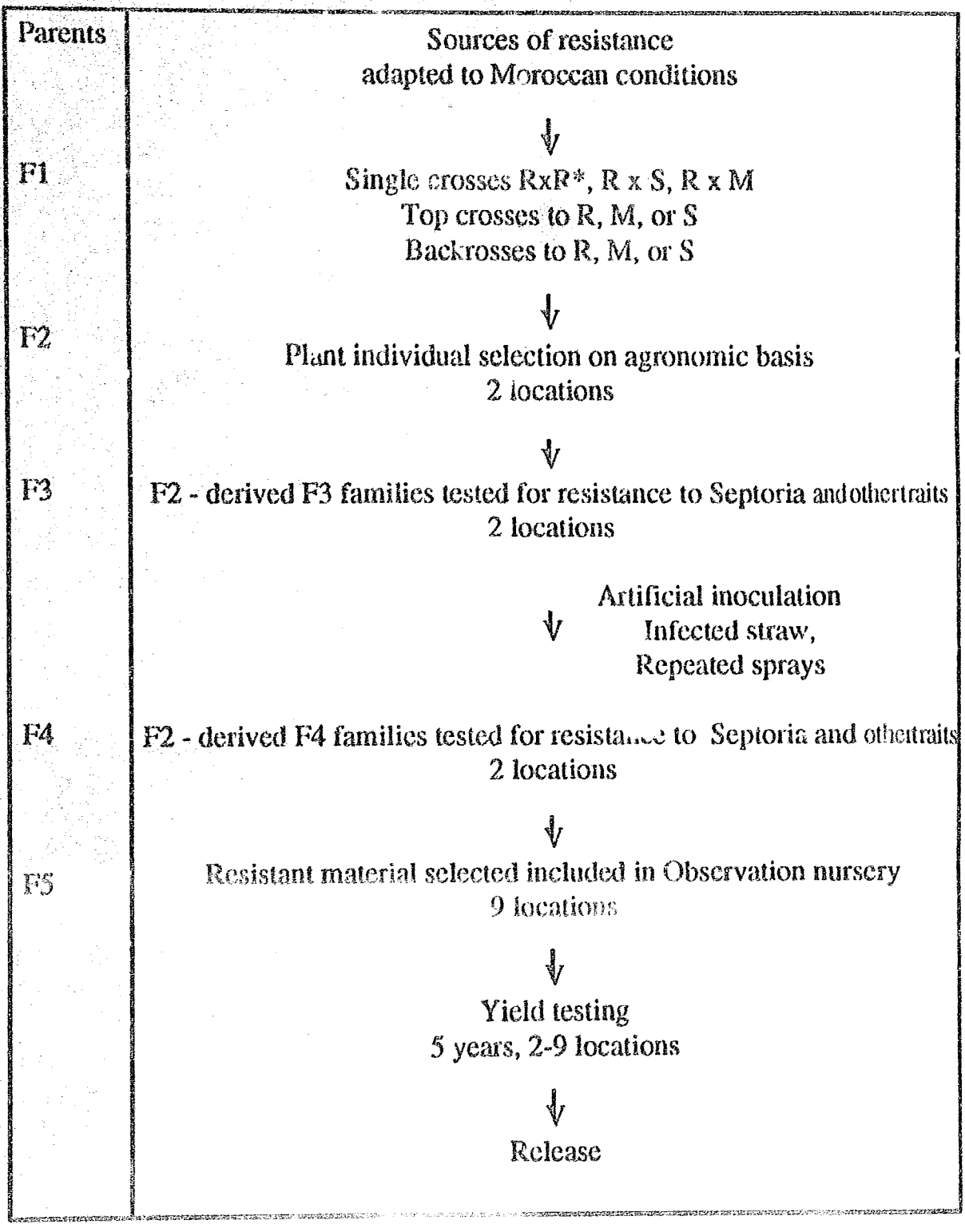
INTRODUCTION

Septoria tritici blotch, induced by **Mycosphaerella graminicola** (Fuckel) Schoeter, is a disease of wheat (**Triticum aestivum** L. em Thell.) which is becoming increasingly important with the introduction of early semidwarf cultivars. These cultivars are high yielding but susceptible to this disease. New cultural practices associated with these cultivars are also contributing to disease development. Success in breeding resistant material has been limited due to several factors. First, while selection for resistance is generally done in the field on fully developed plants, inheritance studies were carried out on seedlings in the greenhouse. A recent study has provided information on the inheritance of adult plant resistance in the field (Jlibene et al., 1992). Second, the inherent presence of the association of semidwarfness and earliness with susceptibility to the disease, has complicated breeding for resistance. The results of selection were often disappointing, because selected material tended to be late and tall. Selection techniques which reduce the association of height-earliness and susceptibility will most likely increase the efficiency of the breeding programs. Third, progress in breeding for resistance may be limited by the use of the 0-9 scale disease assessment method commonly used in the field (Saari and Prescott,

Figure 1. : Selection path used to develop Septoria resistant wheat varieties.



*R = resistant, M = medium resistant, S = susceptible.

1975) because this methode contributes to the height- susceptibility association (Jlibene et al., 1991). The use of disease infection of the penultimate leaf has been suggested by Jlibene et al. (1991). Fourth, beside resistance Septoria to a large number of traits must be considered in variety development.

A system of selection wich takes into consideration all mentioned aspects would likely be efficient. The objective of this report is to present a method used in Morocco to develop cultivars adapted high yielding and resistant to Septoria .

METHOD USED

The choice of approriate parents to use for crosses, the type of crosses, and the use of appropriate field lay out, inoculaion, and disease assessment techniques, and the selection procedure are important components to any successful breeding program. The proposed method is outlined in Figure 1.

Parents

Adapted cultivars high yielding, semidwarf, early, resistant to Septoria and leaf rust (**Puccinia recondita** f. sp. tritici) were used as parents. This material could be found in specialized nurseries from the International Maize and Wheat Improvement Center (CIMMYT). Data from Morocco and other locations in the world (CIMMYT reports) were consulted. Priority was given to cultivars with many desirable characteristics besides yield. Moroccan commercial cultivars, susceptible (S) to Septoria, have been crossed to resistant (R) or medium resistant (M) lines.

Crosses

Since the parents were adapted single crosses, topcrosses and backcrosses could be utilized. Single crosses of the type RxS, MxM, RxM and RxR were made. Crosses among resistant or medium resistant lines were made to combine resistance genes (if different) from both sources without losing in yield. SxS crosses were not made. The F1's were also backcrossed to the donor parent to concentrate Septoria resistance genes, or topcrossed to another Septoria resistant or Rust resistant to increase the level of resistance to Septoria and Rusts. Backrosses and topcrosses to the donor parent were possible because all parents were adapted.

Techniques

Design

Plots were two-rowed, 30 cm apart, and 2.5 meters long. Spacing between plots was 60 cm to reduce neighboring effect. To facilitate disease development plant density was not too high (100 kg/ha). Dense populations may interfere with the progress of the disease to upper parts of the canopy since rain splashes carrying spores may be intercepted by the dense foliage. Entries were not replicated but, susceptible checks were repeated every 10 entries.

Inoculation

Straw collected from infected field, was spread between rows at tillering. This technique resulted in early estabishment of the inoculum. Inoculations using spore suspension were also used, but were not always successful. To reduce height effect, the suspensions were spread over the plant canopy. Spray inoculations were repeated several times during the season to reduce maturity effect.

Disease assessment

Disease infection was assessed at the plant level because symptoms of some other diseases, and physiological disturbances may be mistaken for Septoria when this one was assessed on a whole-plot-basis. Disease infection of the penultimate leaf, as recently suggested (Jliben et al., 1991), was used, where infection of the leaf bellow the flag leaf is recorded on a random sample of plants.

Selection

Selections were made in F2 for leaf rust (**Puccinia recondita f. sp. tritici**), stem rust (**P. graminis f. sp. tritici**) resistance and other high heritable traits on a single plant-basis. Selection for resistance Septoria to started in F3 or equivalent (selfed backcrosses (BCF2) and selfed topcrosses) and was done on a plot basis. Agronomic traits such as plant height, earliness, number of tillers, spike size, spike fertility, were considered as well.

Selection intensity was moderate (25%). Visual selection was done in the field, for resistance, to Septoria resistance to leaf rust, to resistant stem rust, and agronomic type, and selection for seed quality occurred later in the laboratory. Both selections involved many traits. As a result, several important traits were either affected in the desired direction or unaffected (Table1). Days to flowering, resistance to stem rust, and kernel weight, were affected in the desired direction, Plant height, resistance to Septoria, and grain filling period were not affected much. It is important that similar levels of resistance to Septoria were maintained in the selected materials. This could be an advantage in situations where selection for Septoria resistance can not be done due to poor disease divelopment.

From 868 F_3 and BCF_2 entries tested at Marchouch and Sidi El Aidi experimental stations in 1987, 360 entries were visually selected (Table 1). This high selection of 41% of the total entries selected is likely due to the adapted parents. Among the selected entries 60% were resistant to Septoria. This represents good progress in selection for resistance to Septoria and good agronomic type.

Selected lines were evaluated at Sidi Aidi and Marchouch during 1988 growing season for early vigor, resistance to rusts, height, earliness, yield components, and resistance to Septoria. Lines identified in 1988 were grown at Sidi El Aidi and Marchouch in 1989. The frequency of resistant lines was a third of the 852 entries. All classes of reaction were observed with natural infection from 0% to 100% infection.

The best resistant 331 lines (less than 50% infection) were tested in a specialized nursery for Septoria at Sidi El Aidi and Marchouch during the 1990 season. **Septoria tritici** development was low. However, 143 lines (43%) showed no symptoms of the disease at Marchouch, while 50% infection was noted on susceptible entries. Selected lines from this nursery will be grown in the 1991 Maghreb S. tritici screening nursery, grown in 4 locations in Morocco, 2 in Algeria, and 2 in Tunisia.

The best 49 lines were incluced in Morocco yield trials at 4 locations during the 1990 season. Their yield surpassed the yield of the variety check 'Nasma' and they had improved resistance to Septoria (Table 2). Resistance could not be

Table I : Percentage of wheat lines after selections in the field at Sidi El Aidi, and the laboratory, 1987.

Criteria	F3			BCF2		
	BS	S1	S2	BS	S1	S2
Total number of entries	458	249	182	410	233	177
Percentage selected (%)	-	54	73	-	57	76
Septoria ≤ 3 (%)	67	61	65	57	54	58
Height of Nasma ± 15 cm (%)	90	94	96	76	90	76
Flowering of Nasma ± 3 days (%)	32	57	61	28	51	54
Maturity ≤ Nasma (%)	51	50	47	68	53	53
Filling period (≤Nasma) (%)	99	91	98	99	97	98
Stem rust (≤MS) (%)	43	54	52	56	67	80
Kernel weight (≥Nasma) (%)	14	19	19	10	11	12

* BS = Before selection, S1 = field selection, S2 = Seed quality selection (Lab.)

Table II . Average grain yield of promising wheat lines resistant to Septoria and their yield advantage over the check Nasma from 3 locations in 1990.

Trial	Number of lines		Average grain yield (kg/ha)		
	tested	selected	Entries	Nasma	% of Nasma
BT90EP1	8	2	4016	3272	123
BT90EP2	6	4	4223	3578	118
BT90EP3	7	4	3496	2208	158
BT90EP4	16	7	4724	3858	122
BT90EP5	12	5	4710	3600	131
Total / Average	49	22	4234	3303	130

*Selected 22 lines included in 1991 yield trials.

definitely assessed because the infection level was low. Weather conditions were not inductive to Septoria due mainly to February drought. Twenty-two bread wheat selections have been included in the 1991 'intermediate yield trial' at 6 locations (Table 2).

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CONCLUSION

An improved method for breeding wheats resistant to Septoria tritici blotch has been designed and used. It utilizes the most recent information on the genetics of resistance to Septoria, the epidemiology of the disease, and multiple trait interdependence. Ways to efficiently exploit the genetic variability of resistance have been incorporated. Adapted cultivars with medium or high resistance to Septoria were intercrossed and/or crossed to commercial cultivars. Inoculation technique helped reduce plant height and earliness influence on Septoria readings. Assessment of Septoria on the penultimate leaf was suggested for more precise scoring that can be acheived with limited plant height and earliness influence. Recent inheritance studies (Jlibene et al., 1992, Van Ginkel et al., 1987), showed that selection for resistance to Septoria to can be effective if appropriate methods are used. The interdependence of agronomic traits is also considered in the selection process. As result of using this method, resistant cultivars with high yield level have been produced.

RESUME

La septoriose (**Septoria tritici/Mycosphaerella graminicola**) est vraissemblement la maladie du blé la plus importante au Maroc actuellement.

Elle ne touchait que les feuilles de base des variétés hautes et tardives qui étaient cultivées avant 1968 au Maroc. Ce n'est qu'après l'introduction de nouvelles variétés semi-naines et précoces, capables de répondre à des doses élevées d'azote sans verser, que cette maladie a pris de l'importance. Malgré la vulnérabilité de ces variétés, leur protection est largement justifiée par leur niveau élevé de production. Le moyen de contrôle efficace le plus pratique reste la résistance variétale. Cependant, l'éxistance de corrélations négatives entre la hauteur et la résistance et entre la maturité et la résistance complique le travail de sélection. Ce qui nécessite la mise au point de méthodes efficaces de sélection. Celle que nous avons préconisée a été présentée et discutée à la lumière des résultats obtenus. La méthode consiste à choisir judicieusement les parents, à faire des croisements appropriés et à utiliser des techniques efficientes d'inoculation, de notation et de sélection.

MOTS CLÉS : Mycosphaerella graminicola, Triticum aestivum, résistance

ABSTRACT

Septoria tritici bloch, a major foliar disease of wheat (Triticum aestivum L. em Thell.) is induced by the fungus Mycosphaerella graminicola (Fuckel) Schroeter, and causes severe yield reductions world-wide. When tall late cultivars were grown, it was a minor disease but became serious following the 1969 introduction of high yielding semidwarf, early maturing varieties. These varieties, when grown under heavy nitrogen fertilization without lodging, have large yield increases. High nitrogen application, semi-dwarf stature, early maturity, weed control, and early planting all contributed to the dramatic increase in disease incidence. In high yield potential areas, wheat will continue to be grown with realatively high inputs. However, most new varieties are susceptible to **S. tritici.** While genetic resistance is the most efficient and cost-effective control measure, breeding is often complicated by the negative correlations between host resistance, plant height, and early maturity. Because multiple traits must be considered in variety development, efficient selection methods are needed. The method consists of choosing appropriate parents and types of crosses and using efficient inoculation, disease assessment , and selection techniques. The results are rewarding. High yielding adapted cultivars resistant to Septoria have been produced.

KEY WORDS : Mycosphaerella graminicola, Triticum aestivum, resistance.

ملخص

مرض التبقع السبتوري يعتبر أهم الأمراض التي تضر بأوراق القمح بالمغرب حاليا. لم تكن الإصابة تقتصر قبل أواخر الستينات إلا على الأوراق السفلية، عندما كانت الأصناف المستعملة آنذاك ذات قامة ومرحلة نمو طويلتين.

لكن استعمال الأصناف الجديدة والتي تمتاز بقصر القامة وبكرة النضج وكثرة الانتاج لمقاومتها للرقاد واستقامتها من الكميات العالية للنايتروجين، ساهم في ارتفاع حجم الإصابة بهذا المرض. وبما أن علو مردودية هذه الأصناف يحتم علينا وقايتها، فلا بد من إيجاد وسيلة لمحاربة هذا الداء. والتحسين الوراثي لمقاومته يفرض نفسه كأحسن وسيلة، لكن ارتباط المقاومة بطول القامة ومرحلة النمو يجعل عملية انتخاب النباتات المقاومة صعبة. مما يضطرنا إلى إيجاد وسائل أكثر نجاعة.

لذلك قمنا في هذا المنشور باقتراح طريقة لتحسين مقاومة القمح الطري لمرض التبقع السبتوري وتحليلها على ضوء النتائج المحصل عليها. وهذه الطريقة تعتمد الإختيار الأنجع للفحول قصد تهجينها ونوع التهجين وتقنيات التعميم الفطري وتقييم النباتات وانتخابها.

د. محمد جليبن

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Code de langue des descripteurs (cercler obligatoirement celui qui convient)

	Etiquette	Données (à dactylographier)
Descripteurs AGROVOC pour l'index matière dans Agrindex	800	~~METHODE D'AMELIORATION~~ TRITICUM AESTIVUM; VARIETE A HAUT RENDEMENT; RESISTANCE AUX MALADIES; SEPTORIA; MAROC (PRIMAIRE) (Séparer les descripteurs par un point virgule (;) et un espace. Faire précéder les propositions de nouveaux descripteurs par un point d'interrogation (?))
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Résumé	860	Presentation d'une methode jugee efficace pour la selection de cultivars de blé au haut rendement et plus resistant a la septoriose (Septoria tritici)

FIN

النهاية

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VUES

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