Genetic characterization of seedling and adult plant resistance against three rust diseases in the 22nd SAWSN CIMMYT Nursery

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INTRODUCTION

The three rusts of wheat, namely; stem rust *(Puccinia graminis* f. sp. *tritici)*, leaf rust *(Puccinia recondita)* and stripe rust *(Puccinia striiformis* f. sp. *tritici)* constitute the major group of diseases that cause yield losses worldwide[1]. Resistance to diseases can be controlled by seedling or adult plant resistance (APR) genes. Combination of both types of genes may be present in a single genotype. Seventy six entries belonging to the 22nd Semi-Arid Wheat Screening Nursery (SAWSN) were screened to determine the presence of genetically characterised genes and to identify new sources of resistance. Results presented in this paper also reflect on the extent of genetic diversity of genotype for rust resistance.

METHODOLOGY

The 22nd SAWSN was tested in the greenhouse against an array of pathotypes for postulation of seedling resistance genes and evaluated in the field against the commercially important pathotypes of three rust pathogens. Stripe rust assessment in the greenhouse was made on a 0-4 scale[2]. For stem rust and leaf rust assessments were made on a scale described by Stakman *et al.*[3] with some modifications proposed by Luig[4]. Field assessment of adult plant responses to three rust diseases was based on a 1-9 scale[5]. The adult plant resistance genes *Lr34* and *Sr2* were identified by using molecular markers $swm10_{211}$[6] and $stm560.3_{171}$[7], respectively. Marker $(Gb)_{130}$[8] was used to confirm the postulation of *Lr19*.

RESULTS

SEEDLING RESISTANCE

Stripe rust

Twelve entries (16%) carried the 1BL.1RS (wheat-rye) translocation (Fig. 1). This translocation carries rust resistance genes *Yr9*, *Lr26* and *Sr31* (9). Stripe rust resistance genes, *Yr6*, *Yr7, Yr9*, *Yr17* and *Yr27* were present either singly or in combinations in 27 entries (Table 1). *Yr9* was postulated alone in six entries and in combination with *Yr27* in five entries. In one entry *Yr9* was postulated with some unknown resistance. Resistance genes in 14 entries could not be postulated with the current set of pathotypes. Thirty five entries did not carry any seedling stripe rust resistance gene.

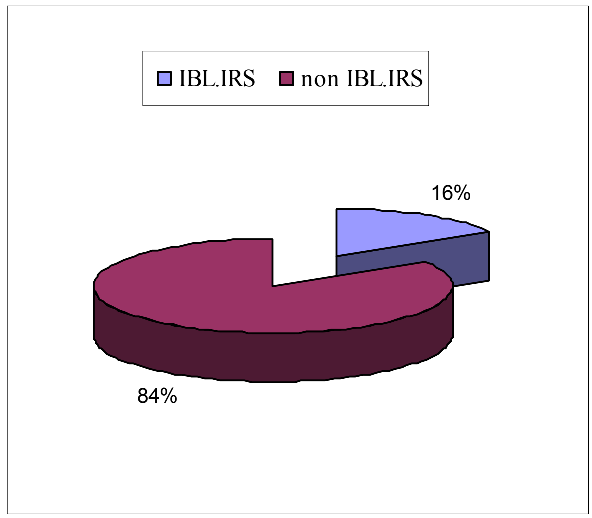

Fig 1. Occurrence of IBL.IRS translocation in 22nd SAWSN

Table 1. Frequency of stripe rust resistance genes in the 22nd SAWSN

Postulated gene	No. of entries
Yr9	12
Yr27	8
Yr7	4
Yr6	2
Yr17	1
Unknown	14
Nil	35

Leaf rust

Leaf rust resistance genes *Lr1*, *Lr3a*, *Lr13*, *Lr16, Lr19, Lr23, Lr24, Lr26, Lr27+Lr31,* and *Lr37* were postulated in the 22nd SAWSN (Table 2). Genes *Lr13, Lr27+Lr31* and *Lr3a* were present in different combinations in 22, 20 and 16 entries, respectively. Resistance in two entries could not be explained with the pathotypes used in this study. Two entries did not carry any seedling leaf rust resistance. The presence of *Lr19* was confirmed by using molecular marker $(Gb)_{130}$[8].

Table 2. Frequency of leaf rust resistance genes in the 22nd SAWSN

Gene	No. of Entries
Lr13	22
Lr27+Lr31	20
Lr3a	16
Lr26	12
Lr23	7
Lr16	5
Lr37	5
Lr24	4
Lr19	1
Lr1	2
Unknown	2
Nil	2

Stem rust

Stem rust resistance genes *Sr6, Sr8a, Sr9g, Sr12, Sr17, Sr23 Sr24*, *Sr30, Sr31* and *Sr38* were postulated either singly or in different combinations. *Sr24* was postulated alone in three entries. Resistance genes *Sr30, Sr17* and *Sr8a* were postulated in 43, 38 and 31 entries, respectively, in different combinations. Resistance carried by four entries did not display differential responses against pathotypes used in this study (Table 3).

Molecular detection of *Lr34/ Yr18* and *Sr2*

Of 76 entries *Lr34/Yr18* and *Sr2*-linked markers indicated the presence of these genes in 75% (57), and 92% (70) of entries, respectively (Fig. 2).

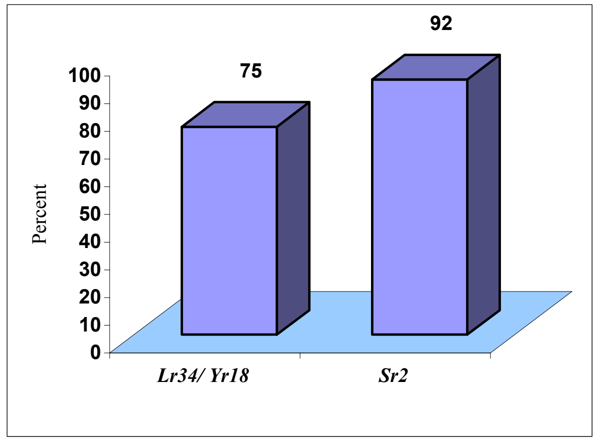

Fig. 2. Percentage occurrence of *Lr34/Yr18* and *Sr2* across 22nd SAWSN

Table 3. Frequency of stem rust resistance genes in the 22nd SAWSN

Postulated gene	No. of entries
Sr30	43
Sr17	38
Sr8a	31
Sr31	12
Sr23	10
Sr38	7
Sr24	6
Sr9g	2
Sr12	1
Sr6	1
Unknown	4

Adult plant responses

A relatively higher proportion (93%) of the entries exhibited low adult plant stripe rust responses (rust score 2, 3 and 4) under field conditions. This was followed by leaf rust (86%) and stem rust (68%). No entry was susceptible to stripe rust in field, whereas, some entries were moderately susceptible and susceptible to leaf rust and stem rust in the field, respectively (Table 4).

Table 4. Frequency of adult plant resistance responses against the three rust diseases across the 22nd SAWSN

Score	No. of Entries		
	Stripe rust	Leaf rust	Stem rust
2	64	35	31
3	6	21	11
4	1	9	10
5	5	6	11
6	-	3	10
7	-	2	2
8	-	-	1

CONCLUSIONS

- Seedling resistance genes , *Yr6*, *Yr7, Yr9, Yr17, Yr27,* *Lr1*, *Lr3a*, *Lr13*, *Lr16, Lr19, Lr23,* *Lr24, Lr26, Lr27+Lr31, Lr37, Sr6, Sr8a, Sr9g, Sr12, Sr17, Sr23 Sr24*, *Sr30, Sr31* and *Sr38* were postulated.

- Genetic diversity in term of effective seedling resistance genes appeared to be narrow.

- Adult plant resistance genes *Lr34/Yr18* and *Sr2* were present in very high proportions of entries.

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