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Resistance to Leaf Rust in Coffee Carrying S_H3 Gene and others S_H Genes

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ABSTRACT

The aim of this work was to evaluate the resistance to rust in coffee carrying S_H3 gene and other S_H genes. Twenty one CIFC's coffee trees with several resistance genes S_H were evaluated in field conditions. All the evaluated coffees carrying S_H3 gene presented resistance to the rust. It was possible that rust races with the virulence gene v3 in the Paraná State didn't exist. The S_H3 gene in combination with genes S_H5, S_H6, S_H7, S_H8, S_H9 and S_H? would be very important to obtain cultivars with more durable resistance to the rust.

Key words: *Hemileia vastatrix*, cultivars, breeding, durable resistance, coffee crop, differential clones

INTRODUCTION

The rust (*Hemileia vastatrix* Berk. et Br.) is the main coffee disease in the world. In Paraná State, Brazil, the annual average damage is around 50 %, varying from 10 to 90% depending on several factors such as the environment and yield of the year. This disease is more important for the coffee crop than frosts that occur once each 6, 9 or 12 years. The intense defoliation provoked by rust disease in the autumn and winter results in nutritionally deficient plant, predisposing for drought and frost.

The chemical control of the disease is efficient and economically viable, but it is dependent of funds, technology and enabled operators, beyond the climatic conditions, becoming uncertain its real efficiency. Although potentially efficient, the cost of control varies between US$ 200 and US$ 500 / ha / year, making it difficult for the farmers with low prices of the coffee.

The use of resistant cultivars is the better way to control this disease, economically efficient and ecologically correct. Nine dominant genes named S_H1, S_H2, S_H3, S_H4, S_H5, S_H6, S_H7, S_H8 and S_H9 were identified conferring resistance to the *H. vastatrix* (Noronha-Wagner and Bettencourt, 1967; Bettencourt and Noronha-Wagner, 1971; Bettencourt et al., 1980). S_H1, S_H2, S_H4 and S_H5 genes confered resistance to some races of *H. vastatrix* and were identified in pure arabic coffees from Ethiopia. S_H3 gene supposedly is derived from *Coffea liberica*, and S_H6, S_H7, S_H8 and S_H9 genes from *C. canephora*, one of the genitors of the "Híbrido de Timor" ("HDT") and others interspecific hybrids like the "Icatu". (Bettencourt and Rodrigues Jr., 1988). Rodrigues Jr. et al. (2000) have confirmed the existence of other resistance genes, beyond S_H6, S_H7, S_H8 and S_H9, in derivatives of "HDT" and other interspecific hybrids due to defeated resistance in some of these coffee trees in relation to the new rust races.

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The fungus causing this disease, *H. vastatrix* Berk. et Br., is of high mutability, breaking quickly the coffee resistance genes. Várzea et al. (2002) reported its 40 physiological races.

Recently, rust races have been identified with great virulence specter, like the race XXXIX, with seven virulence genes (v2, 4, 5, 6, 7, 8, 9), isolated from Indian samples (Várzea et al., 2002). Physiological races of the leaf rust already had defeated almost all S_H resistance genes. Many coffee cultivars considered resistant in the past are now presenting susceptibility. For a perennial crop like the coffee, where a cultivar needs yield lifespan of at least 15 years, the durable resistance to leaf rust is very important to be a successfull cultivar. The resistance genes S_H1, S_H2 and S_H4, alone or in combinations, have not provided durable resistance (Eskes, 1983). The S_H3 gene and certain genes of *C. canephora* like of the "Híbrido de Timor" and "Icatu" can be more efficient to get durable resistance, especially when used in combinations (Bergamin-Filho, 1976; Eskes, 1983).

Eskes (1989) reported that the S_H2 gene didn't present rest resistance, therefore, when coffees with this gene were inoculated with races carrying v2 virulence gene, high susceptibility occurred. Genotypes with genes S_H1 and S_H4 present less disease at field than coffees without these genes if exposed to races with the v1 and v4 genes, respectively. However, this can be due to minor genes present in these genotypes. Varieties with gene S_H3 have shown different levels of rest resistance, indicating the great importance of this gene. Eskes (1983) reported that the rest resistance could promote durable resistance to the rust. Bergamin-Filho (1976) and Eskes (1983) observed that coffee plants carrying S_H3 gene were very promising to get durable resistance.

Thus, the aim of this work was to evaluate the resistance to rust in coffee plants carrying S_H3 gene and others S_H genes on field conditions in Londrina, Paraná, Brazil.

MATERIAL AND METHODS

The field assay was established in March 2002 at IAPAR's Experimental Station (23º 22' latitude south; 51º 10' longitude west) in Londrina, Paraná State, Brazil, on the spacing 2.5 m x 1.5 m. The altitude of the place is 585 m, the annual average precipitation is 1610 mm, annual average temperature of 20.8 °C and relative humidity of air is 71 %.

One plant of each of 21 CIFC's coffee trees with several resistance genes S_H were evaluated. Eight of these genotypes were differential coffees for rust physiological races. The characterization of the evaluated coffees with respective resistance genes and resistance groups are presented in Table 1.

The leaf rust incidence evaluation was done in July 2004 in a period of intense attack of *H. vastatrix*. The score scale used in this evaluation varied from 1 to 5, where: 1 = plants without lesions on the leaves; 2 = leaves with few chlorotic spots (1 to 5 spots) without spores, where the injured leaf percentage on the plant varies from 1 % to 9 %; 3 = leaves with few chlorotic spots (1 to 5 spots) with spores, where the injured leaf percentage on the plant varies from 1 % to 9 %; 4 = number of lesions with spores on leaves varying from 6 to 25 and injured leaf percentage between 10 % to 35%; and 5 = number of lesions with spores on leaves more than 25 and injured leaf percentage more than 35%. Plants with scores 1 and 2 of rust incidence were considered resistants and with scores 3, 4, and 5 as susceptibles ones.

RESULTS AND DISCUSSION

All coffee trees carrying S_H3 gene presented resistance to the rust with the physiological races present at IAPAR (Table 1 and Fig. 1). On differentials 33/1 and H153/2, few injuries provoked for the rust were observed, however without spores. Bettencourt (1981) observed that all the differentials with S_H3 presented resistance to majority of the 30 existing physiological races at that time, and moderately susceptible and susceptible for some races. Also out of the 40 physiological races characterized by Várzea et al. (2002), only 5 races presented the virulence gene v3.

Races VIII (v2, 3, 5), XI (v1, 2, 3, 5) and XIV (v2, 3, 4, 5), carrying the virulence factor v3, were found in India, where varieties with gene S_H3 have been extensively planted (Bettencourt, 1981). In Brazil, rarely races with S_H3 gene are found. Cardoso (1986) identified races VII (v3, 5) and XVI (v1, 2, 3, 4, 5) in Brazil, where the first one found in samples proceeding from Campinas, São Paulo State, and the second race in samples of Ponte Nova in Minas Gerais State, both with low

aggressiveness. Probably, at Instituto Agronômico do Paraná, rust races with the v3 gene didn't exist, therefore, even on the differential 33/1 carrying only genes S_H3 and S_H5 sporulation was not observed. In Brazil the most common race is the race II carrying virulence gene v5.

Table 1 – Resistance to *H. vastatrix* in CIFC's coffees with 2.5 years old evaluated in July 2004 at IAPAR (Londrina – PR – Brazil). Evaluation of individual plants on the field conditions.

CIFC's coffees	Resistance genes	Resistance groups	Scores of rust incidence	Resistance reaction
128/2 – Dilla and Alghe *	S_H1	A	5	Susceptible
849/1 – Matari *	S_H?	B	5	Susceptible
Bourbon	S_H5	E	5	Susceptible
134/4 – S12 Kaffa	S_H1, S_H4	I	3	Susceptible
87/1 – Geisha	S_H1, S_H5	C	3	Susceptible
32/1 – DK 1/6 *	S_H2, S_H5	D	5	Susceptible
33/1 – S 288-23 *	S_H**3**, S_H5	G	**2**	**Resistant**
110/5 – S4 Agaro	S_H4, S_H5	J	4	Susceptible
H420/2 *	S_H5, S_H8	2	4	Susceptible
1006/10 – KP 532 (pl 31)	S_H1, S_H2, S_H5	L	5	Susceptible
H153/2	S_H1, S_H**3**, S_H5	Z	**2**	**Resistant**
635/3 – S12 Kaffa	S_H1, S_H4, S_H5	W	4	Susceptible
H152/3	S_H2, S_H4, S_H5	Y	3	Susceptible
H151/1	S_H**3**, S_H4, S_H5	X	**1**	**Resistant**
H419/20 *	S_H5, S_H6, S_H9	3	**1**	**Resistant**
HW17/12	S_H1, S_H2, S_H4, S_H5	O	3	Susceptible
H147/1	S_H2, S_H**3**, S_H4, S_H5	T	**1**	**Resistant**
H420/10 *	S_H5, S_H6, S_H7, S_H9	1	**1**	**Resistant**
644/18 – Híbrido Kawisari *	S_H?	M	3	Susceptible
832/2 – Híbrido de Timor	S_H5, S_H6, S_H7, S_H8, S_H9, S_H?	A	**1**	**Resistant**
832/1 – Híbrido de Timor	S_H5, S_H6, S_H7, S_H8, S_H9, S_H?	A	**1**	**Resistant**

* Used as differential clone for rust physiological races by the CIFC.
Supposed resistance reaction.

Differential H420/10 (S_H5, 6, 7, 9) and H419/20 (S_H5, 6, 9) showed resistance in the evaluation accomplished at IAPAR, while the H420/2 (S_H5, 8) presented susceptibility (Table 1). However, these three differentials presented susceptibility to some existing races in the world. This could indicate the absence of physiological races such as XXIX (v5, 6, 7, 8, 9), XXXI (v2, 5, 6, 9), XXXVII (v2, 5, 6, 7, 9) and XXXIX (v2, 4, 5, 6, 7, 8, 9). The CIFC's coffees number 832/1 and 832/2 showed resistance reaction, both with score 1.

The evaluations accomplished in this research indicated that at IAPAR rust races existed with the virulence genes v1, v2, v4, v5 and v8 alone or in combinations. Moreover, race(s) with the gene v? also existed that defeated the S_H? gene(s) of the 849/1 Matari and of the 644/18 Híbrido Kawisari.

The study indicated that coffees carrying S_H3 gene were important sources of resistance to rust for the Paraná. Ito et al. (2005) also observed resistance in coffee selections of the "Catuaí S_H2, S_H3" with complete resistance in IAPAR's field experiments.

It would be necessary to develop coffee cultivars derived from hybridizations between coffee trees carrying S_H3 gene (CIFC's acessions H147/1 = S_H2, S_H3, S_H4, S_H5; H151/1 = S_H3, S_H4, S_H5; and H153/2 = S_H1, S_H3, S_H5) with "Sarchimor" of the resistance group A or with Colombia cultivar aiming at more durable resistance. It could be possible that other resistance genes (S_H?) to rust beyond genes S_H5, S_H6, S_H7, S_H8 and S_H9 in some selections of "Sarchimor", as reported Várzea et al. (2002) existed. These researchers reported that certain progenies of this germplasm, as well in India as at CIFC, still continued to present complete resistance to the new physiological races like the XXXIX (v2, 4, 5, 6, 7, 8, 9) and the same was occurring with some lines of the multiline type cultivar, Colombia.

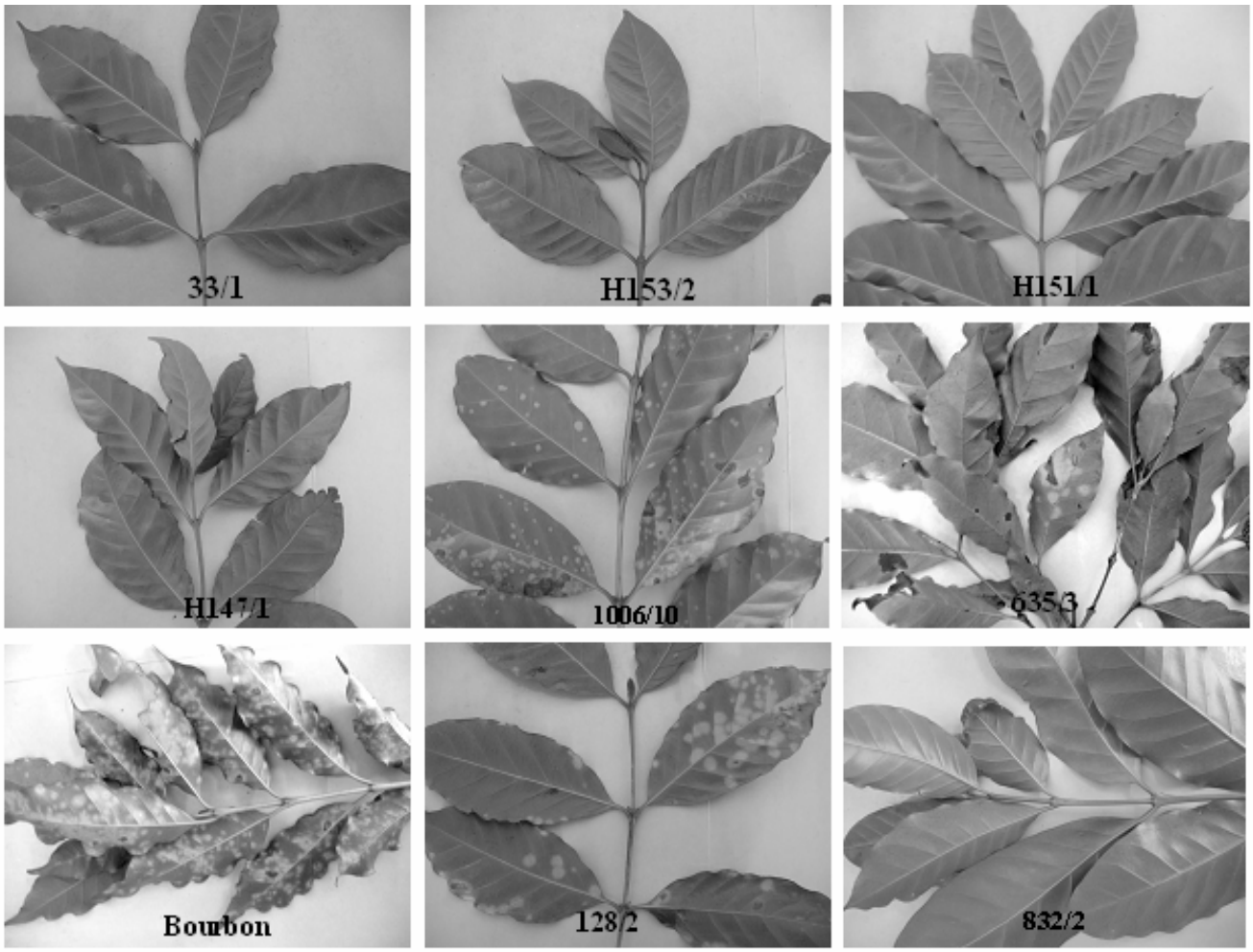

Figure 1 - CIFC's coffee trees with several resistance genes S_H on field conditions at IAPAR (Londrina, Paraná State, Brazil). July 2004

CONCLUSIONS

- All the evaluated coffees carrying gene S_H3 presented resistance to the rust on the field.
- It was possible that rust races with virulence gene v3 in the Paraná State didn't exist.
- Plants carrying S_H3 gene (CIFC's acessions H147/1 = S_H2, S_H3, S_H4, S_H5; H151/1 = S_H3, S_H4, S_H5; and H153/2 = S_H1, S_H3, S_H5) in combination with genes S_H5, S_H6, S_H7, S_H8, S_H9 and S_H? would be very important to obtain cultivars with more durable resistance to the rust.

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RESUMO

O objetivo deste trabalho foi avaliar a resistência à ferrugem em cafeeiros portadores do gene S_H3 e outros genes S_H em Londrina, Paraná, Brasil. Foram avaliados vinte e um cafeeiros do CIFC com diferentes genes S_H de resistência em

condição de alta incidência natural em campo. Todos os cafeeiros avaliados portadores do gene S_H3 apresentaram resistência à ferrugem. É possível que não existam raças de ferrugem com o gene de virulência v3 no Paraná. Plantas portadoras do gene S_H3 em combinação com os genes S_H5, S_H6, S_H7, S_H8, S_H9 e S_H? seria muito importante para obter cultivares com resistência mais durável à ferrugem.

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