COMPONENTS OF PARTIAL RESISTANCE IN *HEVEA* CLONES TO RUBBER TREE LEAF BLIGHT, CAUSED BY *MICROCYCLUS ULEI*[1]

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ABSTRACT

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Several components of resistance that reduce the rate of rubber tree leaf blight have been evaluated. The susceptible leaf period, the fungal pathogen generation period and the number of fungal generations per leaf flush as well as the lesions diameter and the spore production on the lesions, differ strongly among various clones of *Hevea*. These biological, plant inherent factors are suitable for use in controlling of the epidemic development of *Hevea* leaf blight. Some recommendations for the utilization of these factors for rubber tree breeding aiming at resistance to *Microcyclus ulei* are discussed.

RESUMO

Componentes de resistência parcial da seringueira ao mal-das-folhas, causado por *Microcyclus ulei*.

Vários componentes de resistência que reduzem a taxa do mal-das-folhas em seringueira foram avaliados. O período de susceptibilidade do folíolo, o período de geração do patógeno e o número de gerações do patógeno por lançamento foliar, bem como o diâmetro das lesões e a produção de esporos nas lesões diferem fortemente entre os clones de seringueira estudados. Estes fatores podem ser utilizados para reduzir o desenvolvimento epidêmico do mal-das-folhas em seringais de cultivo. Algumas recomendações para a utilização destes fatores no melhoramento da seringueira visando resistência ao *Microcyclus ulei* são discutidas.

INTRODUCTION

Microcyclus ulei (P. Henn.) v. Arx is the causal agent of rubber tree leaf blight, a leaf disease which causes drastic economic losses in natural rubber production on the plantation scale in Brazil (Gasparotto *et al.*, 1984, Junqueira *et al.*, 1988a). Chemical control of the disease is restricted to nurseries, clonal gardens and very young plantations. In spite of intensive research for chemical protection of rubber against leaf blight, no suitable large scale fungicide application technique could be developed as yet for mature plantations (Junqueira *et al.*, 1987b). Alternatively to chemical protection, factors for other control measures should be developed. Resistance breeding, plant management and biological control factors are under study (Junqueira *et al.*, 1987c, 1988b, 1989a, 1989b). Until recently it was impossible to develop detailed resistance breeding programs for *Hevea* to *M. ulei*, because there was no clear information available on the physiological variability of the fungal pathogens and about the plant inherent factors governing the resistance against this disease. Data on fungal races (Darmono and Chee, 1985; Junqueira *et al.*, 1987a) and arrangement of races in physiological groups (Junqueira *et al.*, 1986a, 1986b, 1989b, Junqueira, 1985) as well as on resistance factors of the plant (Giesemann *et al.*, 1986; Lieberei, 1986; Lieberei *et al.*, 1989), led to a better understanding of the host-pathogen interaction of this serious disease and allow a study of the biological components of the pathosystem.

An outstanding component in this host-pathogen interaction is the leaf age resistance which is expressed in the course of leaf maturation of *Hevea* (Blasquez and Owen, 1963, Valois, 1983). As yet it is unknown which factor is responsible for the rapid ontogenic change from a susceptible leaf to a totally resistant leaf. This study presented data on the differences of *Hevea* clones in the onset of leaf age resistance and shows the extent to which fungal development is influenced by the leaf age of a given clone. Evaluation of the data obtained leads to the development of selection factors for plant material which will control the leaf blight on a partial or incomplete resistance level. Some recommendations for the utilization of these resistance components to the control of the rubber tree leaf blight are discussed.

[1] This work was done, during the period when N.T.V. JUNQUEIRA was Researcher in the CPAA/EMBRAPA-Manaus, AM, receiving financial support from EMBRAPA, SUDHEVEA and DFG/GTZ.

MATERIAL AND METHODS

Hevea clones, cultivated in black polyethylene bags, each containing 10 kg of substrate, were grown under local ambient conditions at the Centro de Pesquisa Agroflorestal da Amazônia (CPAA) in Manaus, Amazonas, Brazil. After the second leaf flush inoculations were done according to Junqueira *et al.*, (1986b, 1988a). For the determination of the incubation period (IP, time from inoculation until the occurrence of macroscopic visible lesions), the pathogen generation period (GP, time from inoculation until the production of conidia), number of lesions per 9cm² leaf area (NL), diameter of lesions (DL) and spore production on the lesions, the young leaves of developmental stage B1/B2 (Hallé *et al.*, 1978) were inoculated with isolates highly virulent to the respective clones used. The isolates were chosen out of a set of 32 *M. ulei* isolates, that had been tested for virulence and aggressiveness (Junqueira, *et al.*, 1988a). The DL and spore production were determined 12 days after inoculation. For the determination of the susceptible leaf period (SLP), the inoculations were done on the abaxial leaf surface of each clone at 2, 4, 6, 8, 10, 12, 14 and 16 days after bud burst, using a Paashe air brush, model H3, Chicago, USA. Evaluations were done 12 days after inoculation. The SLP was considered the period from bud burst until the leaf no longer permits the formation of conidia. The generation number of the pathogen per leaf flush (NFG) was determined by dividing the SLP by the GP of *M. ulei*. The development of stroma was evaluated 60 days after inoculation.

RESULTS

Leaves develop resistance against infection by *Microcyclus ulei* during leaf maturation. The SLP is not identical for all *Hevea* clones, but varies considerably (Table 1); and this variation is not restricted to *Hevea brasiliensis*. Pure *H. brasiliensis* clones like the intraspecific hybrids Fx 985, IAN 873 and Fx 4098 reveal variations in SLP comparable to those found for the interspecific hybrids of *H. benthamiana x H. brasiliensis*, e.g. IAN 6323, IAN 717 and Fx 3925, and vary between 12 and 16 days. The *H. brasiliensis* clone Fx 4098 and the *H. benthamiana* hybrid IAN 6323 are characterized by a shorter SLP of 12 days, whereas the shortest SLP of 10 days is shown by the *H. benthamiana x H. brasiliensis* hybrids IAN 6158, IAN 7002, by the pure *H. benthamiana* clone F 4542 two primary selections CNSAM 7665 and CNSAM 7907 of undefined progeny.

The GP of the fungus in the leaves also varies distinctly during the leaf maturation inside and among the differents clones. Generally in the clones with the shortest SLP, the fungal GP is the longest and in clones with the longest SLP the fungal GP is very short. Generally, the *M. ulei* GP increase with the increase of the leaf age. Dividing the SLP by the GP leads to the number of potentially developing fungal generations (NFG) per leaf flush or infection frequency which can be produced on a susceptible *Hevea* leaf. The NFG varies between 1 and 3.

In addition to these data, the diameter of lesions, the spore production and the production of the sexual stromatic structures were evaluated. Generally, the clones with short SLP reveal the smallest lesions on the leaves and lesser sporulation than leaves of the clones with a longer SLP (Table 1). The diameter of lesions also decrease with increase of leaf age. Stroma production up to 60 days after inoculation is observed on all clones with long or short SLP, whereas it does not occur in the clone CNSAM 7907, which has a short SLP.

The incubation period of *M. ulei*, i.e. the time from inoculation with conidiospores until the first macroscopic symptoms in the leaves become visible, did not vary among the clones. Generally, after 3 days the first necrotic, chlorotic or translucent spots appeared. Using 2 x 10^5 spores/ml for all inoculations, the number of lesions was 10 to 13 per 9 cm² leaf area and did not vary among the clones used.

DISCUSSION

For these studies, the *M. ulei* isolates which revealed

TABLE 1 – Components of partial resistance in *Hevea* clones to rubber tree leaf blight[1].

Clones	Canopy Change	Incubation[6] Period (days)	Fungal[7] Generation Period (days)	Susceptible Leaf Period (days)	Calculated[2] Generation Number	Lesion Number	Lesion Diam. (mm)	Sporulations[3] Type	Reaction[5] Type	Stroma[4] Formation
Fx 3925	irreg.	3,0	5,0	16	3,2	13,3	3,4	+++	HS	+
IAN 873	regul.	3,0	5,2	16	3,1	11,8	3,5	+++	HS	+
IA 717	irreg.	3,5	5,2	16	3,1	12,5	3,6	+++	HS	+
Fx 985	regul.	3,4	6,4	14	2,2	12,6	3,4	++	S	+
Fx 4098	regul.	3,3	6,0	12	2,0	12,6	2,3	++	S	+
IAN 6323	irreg.	3,3	5,5	12	2,2	12,4	3,6	+++	S	+
CNSAM 7665	unknow	3,0	5,1	10	2,0	12,0	3,3	+++	S	+
IAN 7002	unknow	3,4	5,5	10	1,8	12,8	2,8	+++	S	+
IAN 6158	irreg.	3,5	7,6	10	1,3	11,6	1,5	+	MR	+–
F 4542	irreg.	3,0	7,6	10	1,3	12,8	1,4	+	MR	+–
CNSAM 7907	unknow	3,5	9,4	10	1,1	10,7	1,7	(+)	MR	–

1 The experiments were done in two growth periods 1985/1986 and 1986/1987, using –12 inoculated leaflet per clone/pathogen combination. Inoculation was carried out with 2 x 10^5 spores/ml.
1 Incubation at 24ºC under 85 to 92% r.H.
2 Number of pathogen generations is calculated by dividing SLP by GP.
3 Sporulation type: +++ abundant spores occurring on lesions of the lower and upper leaf surface, ++ abundant spores only on lessions of the lower leaf surface; + low number of spores (partial sporulation), distributed over the entire lesion area; (+) some spores occurring only at the lesion border region.
4 Stroma formation was evaluated 60 days after inoculation.
5 HS = Highly susceptible; S = susceptible; MR = Moderately resistant. The reaction type was indicated considering all resistance components.
6 Pathogen incubation period = Time from inoculation until the occurence of macroscopic visible lesions.
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the highest degree of virulence to the clones under study (Junqueira, 1985; Junqueira *et al.*, 1988a, 1988b) were used.

Therefore race/clone specific resistance reactions were experimentally excluded. The poor production of spores which is seen on some clones with shortest SLP must rather be due to rapidly occurring physiologic changes of leaf metabolism during maturation (Lieberei, 1984, Lieberei *et al.*, 1989) than to race/cultivar specific interactions. This is underlined by the fact, that 14 different isolates of *M. ulei* isolates tested on IAN 6158 revealed similarly poor spore production (Junqueira, 1985; Junqueira *et al.*, 1988a, 1988b).

The different leaf susceptibility periods found in this study, allow the development of resistance selection factors which lead to disease control on the level of incomplete, partial plant resistance as defined by Parlevliet (1975, 1979) and Zambolim *et al.* (1983). A short SLP of the plant combined with a long GP of the fungus leads to a significant reduction of the number of spore generations of the pathogen produced in one susceptible leaf flush. This can significantly reduce the inoculum density potentially produced. Without doubt, this control factor is a valuable means of controlling the epidemic development of leaf blight disease of the rubber tree.

A further control factor of the epidemic development of rubber leaf blight is the phenological habit of the canopy change. Clones with regular leaf change normally reveal defoliation and refoliation within about 30 days. On the other hand, clones with irregular leaf change develop the new canopy over a period of about two to three months, besides a constant additional emission of new and susceptible leaf flushes, which actuate as host sources for inoculum multiplication of the pathogen. In clones with regular leaf change, intensive control measures have to be taken only from the onset of the new leaf flush and until the SLP is completed. In clones revealing a long SLP combined with a short GP, control measures have to be taken as often as the potential number of fungal generations (NFG) can be produced. In highly susceptible clones with irregular leaf change, the control measurements have to be applied over a considerably longer period of time, until no substantial amounts of new susceptible leaves are produced (Junqueira *et al.*, 1989d). With respect to plant breeding, the recommendation is made to select for plants revealing a low NFG, combined with other factors of partial or incomplete resistance. These may also be expressed in the production of small lesions and a low number of spores produced per lesion. A set of these factors related to incomplete resistance of plant to disease has been given by Parlevliet (1975, 1979) van der Plank (1968), Zambolim *et al.* (1983).

Thus, the clones IAN 6158, F 4542, CNSAM 7907 which reveal a low NFG, less sporulation than the other tested plants and a restriction of lesions size are considered to be relevant for *Hevea* breeding. They are promising for further work because they contain a set of properties needed for incomplete resistance. The pathogen *M. ulei* can produce only one generation of spores in one leaf flush and even when the leaf change is not regular, chemical control is not necessary (Junqueira *et al.*, 1989d). As some of these plants, in contrast to all other clones tested, did not show any formation of stroma on diseased leaves 60 days after inoculation, the number of ascospores which are normally produced in these stromata, must be low or equal to zero in these plants. The combination of these factors together in one clone, obtained by suitable selection and breeding is of great importance to the control of the rubber tree leaf blight.

ACKNOWLEDGEMENTS

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EFICIÊNCIA E ECONOMICIDADE NO CONTROLE DA BRUSONE COM UMA APLICAÇÃO DE FUNGICIDA EM ARROZ DE SEQUEIRO

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RESUMO

PRABHU, A.S., TEIXEIRA, S.M. & ZIMMERMANN, F.J.P. Eficiência e economicidade no controle da brusone com uma aplicação de fungicida em arroz de sequeiro. Fitopatol. bras. 15:214-220. 1990.

Foram realizados três experimentos de campo, com arroz de sequeiro, nos anos agrícolas 1983/84, 1984/85 e 1985/86 em Goianira-GO, Brasil utilizando-se a cultivar IAC 47. Os tratamentos consistiram de diferentes épocas de plantio, com e sem aplicação de fungicida triciclazol (262,5 g i.a./ha) na época da emissão das panículas. A pulverização reduziu a severidade da brusone nas panículas em todos os anos. A produtividade aumentou somente em dois anos em resposta ao tratamento. Os resultados foram superiores nas primeiras cinco épocas de plantio. Considerando as médias de três anos, análise benefício/custo da aplicação do fungicida apresentou resultados positivos no primeiro e terceiro ano e negativo no segundo ano devido as diferenças nas severidades da brusone. Em média, uma aplicação resultou em ganhos de 264 kg/ha.

ABSTRACT

Efficiency and economics of a single fungicide spray in controlling panicle blast in upland rice.

Three field experiments were conducted during crop seasons 1983/84, 1984/85 and 1985/86 under upland conditions in Goianira-GO, Brazil using a widely cultivated rice cultivar IAC 47. The treatments consisted of different planting dates, with and without fungicide application of triciclazol (262,5 g a.i./ha) at heading. Fungicide spray reduced panicle blast severity in all years, however, grain yield increased only in two years in response to treatment. Considering the three year average, the results were superior in the first five planting dates. The cost-benefit analysis showed positive results in the first and third years and negative in the second year due to differences in blast severity. On average a single application of fungicide resulted in grain yield increase of 264 kg/ha.

INTRODUÇÃO

A brusone causada por *Pyricularia oryzae* Cav. é altamente prejudicial ao arroz de sequeiro na Região Centro-Oeste. Sua severidade varia dependendo do sistema de produção adotado e das condições climáticas. Fratinni e Soave (1972) relataram perdas significativas devido à brusone no Estado de São Paulo. Embora a doença afete todas as partes da planta a partir dos 25 dias após semeadura, é nas panículas onde causa os danos mais significativos, já que afeta a fertilidade das espiguetas e o peso dos grãos. Perdas no peso de grãos de 8 a 14% e espiguetas vazias de 19-55%, foram observados em