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Asian Soybean Rust: Breeding Program for Resistance or Tolerance?

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Introduction

Asian soybean rust is the disease that has most worried farmers and researchers in the area of plant breeding since its first evidence in the 2000/01. The Asian rust found extremely favorable conditions for its dissemination in Brazil [1], for example the climatic conditions, the great extension of some crops and the continued monoculture [2]. Thus, in the 2002/03 the fungus had already contaminated almost all the producing areas [3].

This disease is caused by the fungus *Phakopsora pachyrhizi* Syd. & P. Syd, belongs to the phylum Basidiomycota, class Urediniomycetes, order Uredinales and family *Phakopsoraceae* [4]. This fungus is a biotrophic pathogen, therefore it needs alives tissues of the plant to develop and it is not transmitted by seeds. Thus, it survives on soybean plants or alternative hosts.

To the germination of the fungus, it is necessary optimal temperatures between 15ºC and 25ºC. The ideal conditions for the occurrence of infection are 10 to 12 hours (minimum of six hours) of foliar wetness, relative humidity of 75% to 80% and temperatures between 18ºC and 28ºC [5].

The most characteristic symptom appears in the leaves, initially on the adaxial side of the leaf, with small angular points less, with a diameter of less than one millimeter, along with the gray-colored uredospores (spores). In the course of sporulation, the leaf tissue around the lesions changes color according to the reaction of the host to the presence of the pathogen, on both sides of the leaf. If the host is susceptible it acquires light tan or beige color (called a TAN lesion) and if the host is resistant the lesion becomes dark brown (called RB lesion, or reddish brown), being a reaction signal of hypersensitivity [6-8].

The Asian soybean rust cycle consists of the dispersion of uredospores, from infected plants, through the wind. When deposited on a viable host and with favorable climatic conditions the uredospores germinate emitting a germinative tube and then the appressory one. This specialized structure pierces the cuticle and the cell wall, infecting the host [9]. The plant is more attacked in the lower third of the plants, where the microclimate is favorable to the development of the disease. Early leaf defoliation occurs, which can reduce the cycle in up to 15 days, also causing a reduction in grain yield [10].

The control is a set of practices that guarantees the good coexistence between the plant and the pathogen, without significant damage to the crop [11]. The control methods include the use of fungicides recommended for the crop and the management of the off-season called «sanitary empty», which corresponds to the period of absence of live host plants in the field [12]. As well as other strategies: the cultivation of premature cultivars at the time recommended for each region, in order to escape from the period of greatest potential of the inoculum; the less dense planting and the continuous monitoring of the crop, in order to obtain the best control in the best season [13].

The genetic resistance of soybean cultivars to Asian rust is a key component of integrated management for disease control. It is a host defense reaction, resulting from the sum of factors that tend to decrease the aggressiveness of the pathogen. There is already been identified six dominant genes, Rpp1 [14], Rpp2 [6], Rpp3 [15], Rpp4 [16], Rpp5 [7] and Rpp6 [17]. However, some of these genes are no longer effective against the race present in Brazil, since the fungus has high variability and the climatic conditions in the country are favorable for its development [18]. The accuracy of selection of plants with vertical genetic resistance is increased by performing artificial inoculation in controlled environments. However for Asian rust the occurrence of the pathogen in the field is homogeneous since the spores are disseminated through the air, and thus can be evaluated, for example, by a diagrammatic scale containing a set of notes.

Due to the instability of vertical resistance and difficulties in quantifying horizontal resistance, the tolerance study has been used as a breeding strategy to minimize the impact of rust on soybean. Tolerance is the ability of a plant support the attack of the pathogen without the damage being significant in its production, with the visible symptoms of the disease. Thus, generational breeding programs have sought alternatives for field tolerance assessment [19]. A interesting strategy is the use of managements with different types of fungicides aiming the evaluation genotypes in the presence and the absence of Asian rust (losses caused by rust) based on the grain yield and the seed size [20,21].

Based on the above considerations, is it possible that the cultivation of rust-tolerant cultivars can be launched and succeed among producers? Genetic breeding programs for pathogen tolerance have been poorly explored, especially if conducted without considering the resistance. Can the association of resistance and tolerance evaluation be a more promising selection strategy for soybean cultivars? It is necessary to check whether the disease can be controlled by vertical resistance or whether the horizontal resistance must also be associated. And if selection based on rust-tolerant genotypes is reliable. The importance of obtaining tolerant cultivars stems from the fact that they support the disease without drastically affecting productivity compared to non-tolerant plants, requiring a lower number of fungicide application [22].

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