REVISTA TRÓPICA: Ciências Agrárias e Biológicas

Response of Snap Bean Lines to Charcoal Rot Disease

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ABSTRACT

The purpose of this research was to survey *Macrophomina phaseolina* incidences on snap bean from the bank of snap bean germplasm at the *Universidade Estadual do Norte Fluminense Darcy Ribeiro*, so as to start a breeding program aiming at obtaining resistant cultivars. Twenty-nine accesses (F_{10} lines) from the snap bean germplasm bank regarding the reaction to *Macrophomina phaseolina*were assessed. The evaluation was performed 20 days after inoculation, and the response of plants to infection was estimated by a graded scale from zero to five. Five promising accesses were chosen to be considered as genitors in the breeding program in view of resistance, which are related as follows: UENF 7-6-6, UENF 7-10-10, UENF 9-4-14, UENF 14-6-26, and UENF 14-22-102.

Keywords: Plant breeding, disease, yield

RESUMO

O objetivo deste trabalho foi investigar as incidências de Macrophomina phaseolina no feijão-vagem do banco de germoplasma de feijão-vagem da Universidade Estadual do Norte Fluminense de Darcy Ribeiro, a fim de iniciar um programa de melhoramento genético visando à obtenção de cultivares resistentes. Vinte e nove acessos (linhas F10) do banco de germoplasma de feijão-vagem a respeito da reação à Macrophomina phaseolina foram avaliados. A avaliação foi

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realizada 20 dias após a inoculação e a resposta das plantas à infecção foi estimada por meio de uma escala graduada de zero a cinco. Cinco acessos promissores foram escolhidos para serem considerados como genitores no programa de melhoramento, tendo em vista a resistência, que são relacionados da seguinte forma: UENF 7-6-6, UENF 7-10-10, UENF 9-4-14, UENF 14-6 -26 e UENF 14-22-102.

Palavras chaves: Melhoramento de plantas, doença, produtividade.

INTRODUCTION

Snap bean (*Phaseolus vulgaris* L.) is a vegetable of great acceptance and consumption all over Brazil, mostly in the southeast region, especially in Rio de Janeiro State. Yielded especially by small farmers, the crop is destined for the consumption of green pods (1).

The average yield of snap bean in the southeast region of Brazil is approximately 37 mil t/year, and the state of Rio de Janeiro is responsible for 21% of this yield. Nevertheless, the marketing average of snap bean is about 600 t/year, when adding all resale units of the *Central de Abastecimento*-CEASA (Supply Central-CEASA) of the state (2). By this mathematics, the demand is higher than the supply, proving that the cultivation of snap bean is a profitable option for small producers of the north and northwest of Rio de Janeiro State.

Its low demand is related to various causes; among the most predominant, there are diseases of variable etiology, which attack the crop, and lack of better seeds in the market. This concern has encouraged a targeted action of several segments of the productive sector to stimulate the use of higher quality seedsand plants that present resistance, enabling the lowest use of pesticides.

Within the main bean plant diseases, the charcoal rot disease, which the *Macrophomina phaseolina* fungus is the causal agent, is a disease that manifests itself by attacking stem and root, causing great damage (3). This fungi is widely distributed in worldwide and has a wide range of host which includes over than 1600 plant species (4). In Brazil, the disease is found in many yield areas (5) and, its development is favored by some environmental factors such as soil water deficit

and high air temperature, coinciding with when temperatures becomes more severe in dry and hot environments, similar to the southeast region of the country (6). Primary infections may remain latent until the occurrence of environmental stress such as mentioned above.

To obtain snap bean cultivars with high agronomic performance and also resistant to *Macrophomina phaseolina*, it is essential to be aware of the resistance levels in the germplasm bank, which can be applied as donor parent of resistance in directed cross.

Over this context, this research aimed at carrying out a survey of the *Macrophomina phaseolina* incidence in snap bean of the snap bean germplasm bank of the *Universidade Estadual do Norte Fluminense Darcy Ribeiro*, to select potential candidates to start a breeding program to obtain cultivars resistant to this fungus.

MATERIAL AND METHODS

This work was conducted in a greenhouse located at the *Unidade de Apoio à Pesquisa*– UAP (Research Support Unit) of the *Universidade Estadual do Norte Fluminense Darcy Ribeiro* – UENF, Campos dos Goytacazes Municipality, Rio de Janeiro State, Brazil, situated at 21°45'44'' south latitude and 41°17'15" west longitude, between October and November 2017.

There were evaluated 29 accesses (lines F_{10}) of the snap bean germplasm bank (Table 1) as to the reaction to *Macrophomina phaseolina*. It was applied the experimental randomized block design with three repetitions and one plant per plot, totaling 87 plants.

The planting was in 5 liters pots, spacing 1 metre x 0.5 metre, using the Basaplant® Hortaliças commercial substrate composed of pine bark, peat, charcoal, vermiculite, initial fertilization with NPP and micronutrients. Maintenance fertilizations with urea, simple superphosphate, and potassium chloride were performed, in accordance with the culture recommendations, as well as other cultural treatments carried out during the whole cultivation (7).

An isolate of *M. phaseolina* was collected from symptomatic snap plants, taken from the samples sent to the Phytosanitary Clinic of UENF for laboratory analysis. The samples with disease symptoms and signs of the pathogens were taken for the preparation of slides of the reproductive structures for subsequent morphological identification using the Optical Microscopy (OM).

The isolation of the pathogens was performed in Potato Dextrose Agar (PDA) culture medium, added with streptomycin sulphate (0.1g/1000 mL of PDA). Incubation was in PDA medium, at 25 °C. Inoculation was made using mycelial discs from a pure colony of *M. phaseolina*, positioned on the soil surface, where the seedlings had already been set out.

The evaluation was performed 20 days after inoculation, and the plant reaction to the infection was estimated using a graduated scale from zero (without symptoms) to five (dead plants), adapted from (3).

Data analysis was made by means of a descriptive analysis, which resulted in the mean of the grades attributed to each access.

Insert table 1

RESULTS AND DISCUSSION

This survey showed that the mean grades of incidence of the disease ranged from 0 (zero) to 3.67 (Table 2). This result suggests that there is a genetic variability at the level of susceptibility to the disease among the evaluated accesses. It is worth highlighting that there were no accesses that had a maximum mean grade (5), that is, none of the dead plants were verified because of the disease severity.

Insert table 2

In this research, the accesses, which mean grade was between 0 and 1, are considered candidate genotypes to be applied in directed crosses in the breeding program of resistance to

charcoal rot disease. Under this assumption, 32% of the accesses evaluated are potential candidates for donor parent (Graphic 1).

Insert graphic 1

Five accesses among those genotypes candidates for genitors stand out for presenting mean grade equal to 0 (zero), that is, they are resistant to charcoal rot disease (Table 3), and they are UENF 7-6-6, UENF 7-10-10, UENF 9-4-14, UENF 14-6-26, and UENF 14-22-102. In the meantime, (10) also carried out agronomic evaluations of those accesses at two locations in the north and northwest regions of Rio de Janeiro State and concluded that the UENF 7-10-10, UENF 14-6-26, and UENF 14-22-102 F_7 lines (at the moment of the work's execution) are agronomically superior concerning the others. These findings, together with the resistance to charcoal rot disease, confirm that those accesses are strong candidates for genitors in the plant breeding program aiming at resistance. That is because (8) state the success of a breeding program is closely connected to the choice of genitors used at the initial crosses, and the probability of selecting promising genotypes at the end of the work is higher when superior genitors are intercrossed.

Insert table 3

Considering this research focused on selecting candidate lines to start a snap bean breeding program aiming at resistance to *M. phaseolina,* it is worth pointing out the genetic control of this disease. As stated by (9), bean plant resistance to *M. phaseolina*is defined by two dominant complementary genes, suggesting that such resistance has a relatively simple genetic basis. Hence, there is a possibility of using a simple breeding method, for example, the bulk one, as the inheritance is monogenic and dominant.

CONCLUSION

The UENF 7-6-6, UENF 7-10-10, UENF 9-4-14, UENF 14-6-26, and UENF 14-22-102 accesses are candidate genotypes to be used as donor-progenitor of resistance genes to the charcoal rot disease.

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Table 1. Identification of the snap bean accesses (pure lines) assessed in a greenhouse located at the Research Support Unit (UAP) of UENF, Campos dos Goytacazes, 2017.

Treatments	Name of access	Parents
T 1	UENF 7-3-3	UENF 1442 X UENF 1429
T 2	UENF 7-4-4	UENF 1442 X UENF 1429
T 3	UENF 7-55	UENF 1442 X UENF 1429
T 4	UENF 7-6-6	UENF 1442 X UENF 1429
T 5	UENF 7-7-7	UENF 1442 X UENF 1429
T 6	UENF 7-7-9	UENF 1442 X UENF 1429
T 7	UENF 7-10-10	UENF 1442 X UENF 1429
T 8	UENF 7-12-42	UENF 1442 X UENF 1429
T 9	UENF 7-14-44	UENF 1442 X UENF 1429
T 10	UENF 7-20-50	UENF 1442 X UENF 1429
T 11	UENF-7-28-88	UENF 1442 X UENF 1429
T 12	UENF 9-1-11	UENF 1448 X UENF 1429
T 13	UENF 9-3-13	UENF 1448 X UENF 1429
T 14	UENF 9-4-14	UENF 1448 X UENF 1429
T 15	UENF 9-3-23	UENF 1448 X UENF 1429
T 16	UENF 9-24-94	UENF 1448 X UENF 1429
T 17	UENF 9-27-97	UENF 1448 X UENF 1429
T 18	UENF 14-4-24	UENF 1448 X UENF 1442
T 19	UENF 14-6-26	UENF 1448 X UENF 1442
T 20	UENF 14-11-61	UENF 1448 X UENF 1442

T 21	UENF 14-16-66	UENF 1442 X UENF 1429
T 22	UENF 14-22-102	UENF 1448 X UENF 1442
T 23	UENF 15-6-36	UENF 1448 X UENF 1445
T 24	UENF 15-7-37	UENF 1448 X UENF 1445
T 25	UENF 15-8-38	UENF 1448 X UENF 1445
T 26	UENF 15-22-112	UENF 1448 X UENF 1445
T 27	UENF 15-23-113	UENF 1448 X UENF 1445
T 28	UENF 15-25-115	UENF 1448 X UENF 1445
T 29	UENF 15-26-116	UENF 1448 X UENF 1445

*First number = population; second number = family; third number = line of experiment

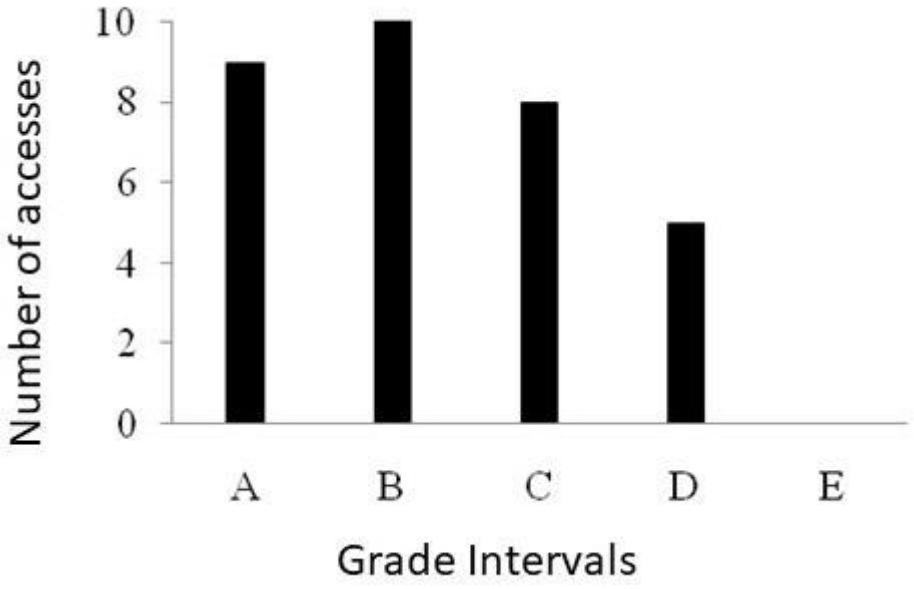
Table 2. Mean grades of incidence of the *M. phaseolina* in 29 snap bean lines evaluated in a greenhouse located at the Research Support Unit (UAP) of UENF, Campos dos Goytacazes, 2017.

Treatments	Mean Grades
T 1	3.00
T 2	1.67
T 3	3.33
T 4	0.00
T 5	3.33
T 6	2.67
T 7	0.00
T 8	1.00
T 9	0.67
T 10	1.67
T 11	1.33
T 12	2.33
T 13	3.00
T 14	0.00
T 15	2.33
T 16	0.67
T 17	1.67
T 18	1.33
T 19	0.00
T 20	3.00
T 21	3.67
T 22	0.00
T 23	1.33
T 24	3.33

T 25	3.00
T 26	0.33
T 27	2.33
T 28	1.67
T 29	1.67

Table 3. Mean grades of *M. phaseolina* incidence in snap bean of group A evaluated in a greenhouse located at the Research Support Unit (UAP) of UENF, Campos dos Goytacazes, 2017.

Accesses	Mean Grade
T7	0.00
T10	0.00
T11	1.00
T12	0.67
T17	0.00
T19	0.67
T22	0.00
T25	0.00
T29	0.33



[1/]Groups of grade intervals: A (0.0 to 1.0); B (1.01 to 2.0); C (2.01 to 3.0); D (3.01 to 4.0); and E (4.01 to 5.0).

Graphic 1. Quantitative distribution of snap bean accesses (pure lines) evaluated by the interval of grades attributed.