FIELD EVALUATION OF PROMISING BREEDING LINES AND VARIETIES OF COMMON BEAN FOR TOLERANCE TO SOILBORNE PATHOGENS.

Abawi, G.S.[1*], Porch, T.G.,[2] and Kelly, J.D.[3] •. [1]Dept. of Plant Pathology & Plant-Microbe Biology, Cornell Univ., Geneva, NY 14456, USA, [2]USDA-ARS-TARS, Mayaguez, PR 00680; 3Dept. of Crop and Soil Sciences, Michigan State Univ., East Lansing, MI 48824; and. •*Presenter (gsa1@cornell.edu)

Abstract

The objective of this study was the identification and incorporation of sources of resistance to major root pathogens into adapted bean varieties being developed in the collaborative Dry Grains Pulses CRSP project. The use of varieties resistant to the prevailing root pathogens is the most effective and practical strategy in the control of root disease of common bean. Field trials of promising lines from the breeding programs of Drs. Kelly and Porch were evaluated in the bean root rot nursery at the Vegetable Research Farm, NYSAES near Geneva, NY over a three year period. This site is heavily infested with *Fusarium solani* f. sp. *phaseoli*, *Pythium ultimum*, *Rhizoctonia solani*, and *Thielaviopsis basicola*. In 2011, 33 lines and varieties were arranged in a randomized block design with 4 replications. Each plot consisted of two rows, 7 m long and 0.75 m apart. Seeds were treated with recommended fungicides (Apron + Maxim) and an insecticide (Cruiser). All maintenance practices were according to recommended commercial guidelines. Root rot severity, among the lines tested varied greatly, ranging from 3.4 [10IS-6567, P07863, B04554 (Zorro)] to 6.0 (CLRK) on the 1 (healthy) to 9 (late stages of decay) scale. Also, many of the tested lines exhibited excellent vigor, productivity and high tolerance to a severe incidence of common bacterial blight, including P07863, RR008, RR016, RR005, and 10IS-6480.

Introduction

Root diseases of beans are widespread and often cause significant yield losses (Fig. 1 and 2), thus reducing profitability of bean production worldwide (1). Root diseases can be caused by a single soilborne pathogen or by a combination of several pathogens, resulting in disease complexes. *Rhizoctonia solani*, *Fusarium oxysporum* f. sp. *phaseoli*, *F. solani* f. sp. *phaseoli*, *Macrophomina phaseolina*, *Sclerotium rolfsii*, *Meloidogyne* spp. are among the major root pathogens known to impact bean production in many countries in Latin America and Africa. However, the occurrence and damage of these pathogens vary greatly among bean production regions as well as among fields within a region (2), thus accurate diagnosis of the prevalent pathogen(s) is critical for effective management. Damage of root diseases is most severe in poor quality soils and on beans growing under various stress conditions. Above-ground symptoms of damage by root pathogens include poor emergence and stand establishment, damping off, unthrifty growth, chlorosis (especially of lower leaves), wilting, premature defoliation, and lower yield. Symptoms on roots and lower stem tissues are variable and diagnostic of the pathogen(s) involved (Fig. 3B). Severely infected roots are reduced in size, discolored and at various stages of decay, thus they are not efficient in absorbing water and nutrients.

The possible involvement of several soilborne pathogens with different mechanisms of pathogenicity has made it difficult to develop a simple and effective disease management program against root diseases of beans. Presently, management of root diseases is possible only through the use of a combination of control options (cultural, biological and chemical) utilizing the principals and strategies of Integrated Pest Management (SOIL - IPM). The critical first step in the management of root diseases is the use of high quality, pathogen-free, and where possible fungicide and insecticide treated seeds (Apron + Maxim + Lorsban or Cruiser is a highly effective seed-treatment in New York). Also, most soil and crop production practices directly and/or indirectly influence soil population of root pathogens and their potential damage. Thus, careful selection of cropping sequences (rotation and cover crops) is critical and should be based on the prevalent root pathogens in the target fields. A soil bioassay with beans is available and will provide a visual assessment of potential severity and damage of root diseases and can be conducted on-farm (3). The bioassays can be used as a tool in assessing the influence of soil and crop production practices in suppressing root diseases or in selecting the proper fields for producing beans (avoiding fields with high potential of root rot damage). However, the single most effective and practical strategy against root diseases is the use of bean cultivars that are resistant to most of the common soilborne pathogen(s) in the production region/fields. Bean germplasm with resistance to a single or multiple pathogens have been reported and fully characterized in a few cases. Unfortunately, commercial bean varieties grown in many production regions still do not exhibit a high level of tolerance to the prevailing root pathogens.

Fig. 1 Severe damage by *Macrophomina* to beans in Rwanda

Fig. 2 Severe damage by Fusarium-wilt to beans in Ecuador

Materials and Methods

Field evaluation trials were established in the bean root rot field at the Vegetable Research Farm, NYSAES near Geneva, NY. This special root rot field has been in continuous bean production for 16 years and is heavily infested with the bean root pathogens *F. solani*. f. sp. *phaseoli* (Fsp), *T. basicola* (Tb), *P. ultimum* (Pu) and *R. solani* (Rs). The 2011 growing season was unusual, with excessive rainfall in the spring until the middle of June, followed by very dry and hot conditions until the early part of August, and then very wet the rest of the season. Undoubtedly, these severe weather fluctuations affected the growth of beans and root rot development, in-spite of the two irrigations that were provided during July. Moderate incidence and severity of Common Bacterial Blight (CBB) occurred throughout the plots, thus the reactions of all the included materials to CBB were recorded. However, symptoms of virus infections observed were at a low incidence and at uneven distribution throughout the plots, thus accurate assessment of the reaction of the materials included was not possible in comparison to previous years.

A total of 33 bean lines and varieties were included in the 2011 trial. Eighteen of the materials included were selected from the trials conducted at the same site during the 2009 and 2010 growing seasons. Dr. Jim Kelly (MSU) and Dr. Tim Porch (USDA/PR) originally provided seeds of most of the latter materials from their on-going breeding programs. In addition, Dr. Tim Porch provided seeds of an additional 10 lines for inclusion in the 2011 evaluation. All the materials were arranged in a randomized block design with 4 replications. Each plot (replicate) consisted of two, 20' (7m)rows that were 2.5 ft. (0.7 m) apart (Fig 3A; 4). All the seeds were treated with the fungicides Apron and Maxim as well as the insecticide Cruiser at recommended rates. A two-row Monosem planter was used to plant the beans on June 28. A complete fertilizer (10-10-10, NPK) was banded by the Monosem planter at a rate of 325 lbs./A. The plots were then sprayed with the herbicide Dual Magnum (1.67 pt/A) as a pre-emergence application. Due to the prevailing dry and hot weather, all the plots were irrigated twice during July. Other maintenance practices were performed according to recommended commercial guidelines. Emergence count was recorded on July 27 and at the same time 20 plants were dugout from each plot (replicate) for root severity assessment. Roots of collected plants were washed free of soil, plants blotted dry with paper towels and their weight was recorded. The roots of the collected plants were then rated for root rot severity on a scale of 1 (healthy) to 9 (>75% of root and stem tissues at late stages of decay) (Fig 3C). An average root rot severity ratings of 1-3, >3-6, and >6-9 are considered as light, moderate, and severe, respectively. Evaluation for CBB, plant vigor and virus symptoms were also recorded on a scale of 1 [healthy (no disease symptoms observed), most vigorous and of high yield potential] to 9 (most severe disease symptoms, poor growth and yield potential). Promising lines and the appropriate checks were harvested on September 12 (total plants/20 ft.-row), plants were air-dried in an empty greenhouse unit, and then dry seed weights were recorded.

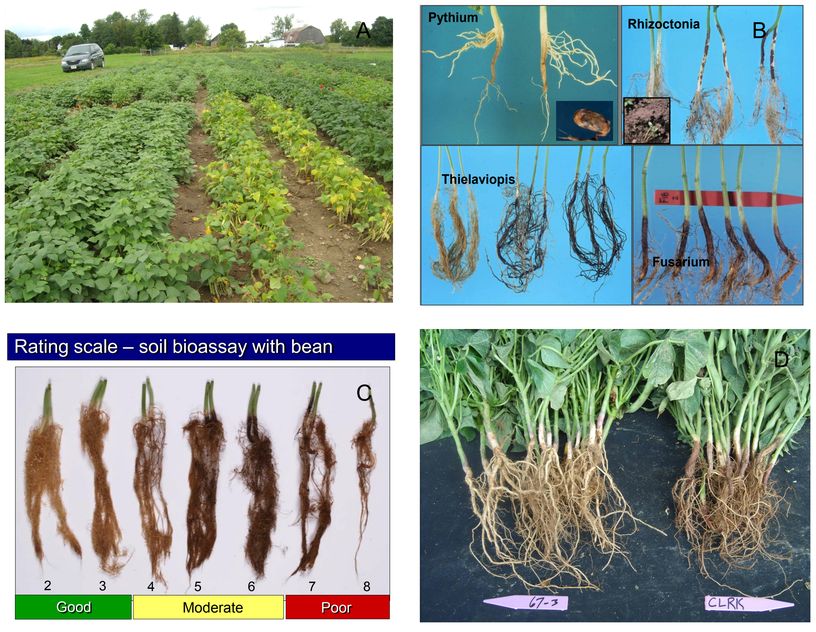

Fig 3 A-D: A) Overview of the section of the 2011 Trial, B) Diagnostic symptoms of various pathogens on roots and stems, C) Evaluation scale , D) A highly tolerant (10IS-6567) and susceptible (CLRK) beans.

Results and Conclusions

Results of the new lines from Dr. Tim Porch's program that were tested in 2011 are presented in Table 1. Root rot severity ratings ranged from 3.4 (10IS-6667) to 6.0 (CLRK) and all the other lines exhibited significantly lower root rot severity ratings in comparison to the check (CLRK) (Fig 3D). The severity of CBB ranged from 2.3 (10IS-6480 and 10IS-7572) to 7.5 (CLRK) and all the lines exhibited high level of tolerance to CBB compared to the check included (CLRK). Growth vigor ratings ranged from 1.0 (10IS-6480) to 6.0 (CLRK) and most of these bean lines appeared highly vigorous and productive.

Similarly, root rot severity ratings of the materials selected from the 2009 and 2010 trials exhibited significant differences in their reaction to root rot pathogens at this location (Table 2). Root severity ratings ranged from 3.4[(BO4554 (Zorro), PO7863 (Eldorado)] to 5.9 (CLRK). Again, there were great differences in the reaction of the materials included to CBB ranging from 1.3 (RR016) to 8.5 (CLRK) and many of the materials in the trial exhibited an extremely high level of tolerance to CBB. Furthermore, the vigor and potential yield ratings of the lines varied greatly and ranged from 1.0 (RR009) to 7.0 (CLRK), and all of the lines included looked good and had excellent ratings.

Table 1. Results of field evaluation of the 10 bean lines provided by Dr. Tim Porch (USDA/PR) planted in the root rot field at the Vegetable Research Farm, Geneva, NY; 2011.

Line code, 2011	Line Code,2010	RRS [(b)] (1-9)	Emergence[(a)] / 20 ft.	CBB[(c)] (1-9)	Vigor[(d)] (1-9)
Trt-CLRK	Trt-CLRK	6.0	70.6	7.5	6.0
42	10IS-7742	4.7	86.0	2.8	3.0
8	10IS-6508	4.7	89.3	3.0	3.5
72	10IS-7572	4.6	85.0	2.8	4.8
34	10IS-7534	4.5	85.5	2.3	2.8
21	10IS-2421	4.3	67.6	2.5	3.3
80	10IS-6480	4.1	83.5	2.3	1.0
79	10IS-6479	3.9	84.8	3.0	3.3
84	10IS-7784	3.8	85.9	3.8	4.0
2	10IS-6702	3.6	78.4	2.5	2.3
67	10IS-6567	3.4	85.9	2.5	2.8
LSD		0.77	9.21	1.3	1.3

Table 2. Results of evaluation of selected bean materials from the 2009 and 2010 root rot trials planted in the root rot field at the Vegetable Research Farm, NYSAES, Geneva, NY; 2011

Treatment Code, 2011	Treatment Code,2010	RRS[(b)] (1 – 9)	Emergence[(a)] / 20 ft.	CBB[(c)] (1 – 9)	Vigor[(d)] (1 – 9)
CLRK	CLRK	5.9	96.6	7.5	6.8
Trt- CLRK	Trt-CLRK	5.5	74.1	8.5	7.0
45	CLRK(2010)	5.4	91.6	7.5	5.3
43	Pink Panther	5.3	91.5	7.5	5.8
101	K90101 (Red Hawk)	5.3	91.5	4.3	2.8
31	RR031	4.3	92.5	2.3	2.5
5	RR005	4.3	87.8	1.8	1.8
256	G08256	4.3	89.6	3.5	2.0
419	S08419 (Rosetta)	4.1	85.1	4.5	1.5
9	RR009	4.1	89.3	2.5	1.0
16	RR016	4.0	86.5	1.3	2.0
6	RR006	3.9	90.1	2.0	1.8
30	RR030	3.9	87.1	2.5	2.3
7	RR007	3.9	89.5	3.3	2.5
135	B09135	3.8	82.0	1.8	2.0
8	RR008	3.9	77.8	2.3	1.3
41	N05311	3.7	93.3	2.3	2.0
39	B05055	3.7	92.6	1.8	2.3
197	B09197	3.7	81.8	2.5	2.5
19	RR019	3.6	80.4	2.1	2.8
1	RR001	3.6	84.5	2.8	3.3
554	B04554 (Zorro)	3.4	91.1	3.8	2.8
863	P07863 (Eldorado)	3.4	89.1	1.8	1.3
LSD		0.74	8.09	1.3	0.09

a) 100 seeds were planted/20' row.
b) Root Rot Severity rating was determined on a scale of 1 (healthy, normal) to 9 (>75% of root and stem tissues affected and at late stage of decay).
c) Severity of Common Bacterial Blight was determined on a scale of 1 (healthy/ no visible symptoms) to 9 (very severe symptoms and with >50% of foliage affected)
d) Growth vigor and potential yield was determined on a scale of 1 (excellent with high yield potential) to 9 (very poor growth and low yield potential).

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