Determination of the diversity of *Collectrichum lindemuthianum* (Sacc & Magn) B&C in Ethiopia

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Abstract

Anthracnose of beans is one of the most widespread and destructive diseases of the crop in Ethiopia. A study was conducted to determine the races of the pathogen by collecting diseased samples of the crop from the major growing areas of the country. Representative isolates of the fungus were inoculated onto 15-days old seedlings of differential cultivars by spraying with conidial suspensions of $1.2x10^6$ spores/ml. After incubation for seven days in the humid chamber under greenhouse condition, disease severity was rated using a CIAT scale of 1-9 and binomial system of race designation. The result showed that races 1, 128,269,499,511,525,712,718,898,952,961,1009,1011, and 906 are present of which races 128 and 511 are common in all locations in Ethiopia. Differential resistance to the races of the fungus was identified in some bean cultivars. Only one local bean cultivar, Roba-1 showed resistance to all races under glasshouse conditions. These results suggest that bean breeding program in Ethiopia should give attention to the race(s) of the pathogen in that location in developing anthracnose resistant cultivars.

Introduction

Common beans are important food legume crop and provides an essential part in the daily diet of Ethiopians. It is grown as a subsistence crop under traditional farming systems usually as an intercrop with maize, sorghum and coffee (Habtu 1994). Under Ethiopian conditions they are well adapted to altitude ranges between 1200m and 2000m, and to rain-fed conditions (Ohlander 1980). Common beans are grown in most parts of Ethiopia, but production is concentrated mainly in the eastern (Hararghe highlands), south and southwest (Sidamo and Wolaita), the western (Kaffa and Wollega) and the rift valley. This wide range of geographical and ecological conditions is associated with a diversity of bean cultivars and diseases (Schwartz and Galvez 1979, Habtu 1987)

The five surveys conducted in the three main production zones (central, eastern and southern) showed that the national area estimated as approximately 300,000 ha. (IAR 1990). Estimates of the national average bean yields were low (600-800 kg/ha). Stewart and Dagnatchew (1967) reported few fungal, bacterial, viral, and nematode diseases in beans in Ethiopia. These earlier records gave little consideration to geographic distribution and economic significance of the diseases. Moreover, disease epidemiology is not known under farmers' conditions.

Bean anthracnose caused by *Colletotrichum lindemuthianum* is a major disease of beans *(Phaseolus vulgaris L.)* in Ethiopia (Stewart & Dagnatchew 1967, Habtu & Dereje 1985, Tesfaye 1991). Evaluation of local and foreign germplasm for resistance to anthracnose at different locations in Ethiopia has indicated pathogenic variability in local populations of the fungus (Tesfaye 1992). Most farmers save their own seed after harvest and thus seed-borne diseases can be devastating, particularly when there is a succession of seasons favoring the pathogen (Goth & Zaumeyer 1965, Zadoks & Scheein, 1979).

Nine races (alpha, delta, epsilon, zeta, eta, teta, kappa, lambda, and mu) of *C. lindemulthianum* were identified from 201 bean isolates collected from 16 states in Brazil (Menezes & Dianese 1988). In Uganda, 19 local isolates of the bean anthracnose pathogen have been tested on a set of differential cultivars. As a result of this test, some isolates with affinities to two races were found to partially overcome the immunity of cultivar Cornell 49-242 (Leaky & Simbwa-Bunnya 1972). The races of *C. lindemuthianum* that have been identified in Kenya include alpha, delta, gamma, epsilon and lambda (Gethuru & Mwangi 1991).

In designating names to apparently new races, varied systems have been used. Although assigning Greek alphabet to races has been the most extensively used system, no international consensus has been reached on a common system (Buruchara 1991). According to Buruchara (1973), based on 41 differential cultivars, 17 races or groups of *C. lindemuthianum* have been reported worldwide. So far, races have been identified and given distinct designations based on different sets of differential cultivars.

Comparison of data and results world-wide is also not easy and justifies the need to use an international standard set of differential cultivars and a common system of race nomenclature. In 1988 a set of 12 differential cultivars and a system of nomenclature were proposed and adopted for use in identification of races of *C. lindemuthianum* by bean workers at CIAT, in Latin America.

In recent years, the occurrence of bean anthracnose in Ethiopia has increased significantly (Habtu 1987), and causes heavy yield losses wherever susceptible bean cultivars are grown (Tesfaye 1996). However, very little information is available on variability (race) of the pathogen, epidemiology and management of the disease in the country. Therefore, the objective of this study was to determine races of *C. lindemuthianum* existing in Ethiopia.

Material and Methods

Eighty isolates of *C. lindemuthianum* were collected from Ambo, Nazareth, Modjo, Meki, Ziway, Awassa, Arsi-Negele and Areka from naturally infected bean pods. Infected pods were surface-sterilized with sodium hypochlorite and placed in polyethlene bags for 5-6 days. Isolation was made on bean pod juice agar and sub-cultured on the same medium at intervals of four weeks (Pastor-Corrales 1992).

Race identification was based on reactions of a set of internationally standardized differential cultivars to the isolates. The set of differential cultivars used in this study was composed of 12 cultivars of *P. vulgaris* obtained from CIAT, Colombia. These cultivars differ in their genes for resistance or susceptibility to one or more races of the pathogen (Goth & Zaumeyer, 1965 and Pastor-Corrales, 1992).

The seeds of each differential cultivars were sown in a plastic pot with a diameter of 15 cm following the procedure described by Tesfaye (1991). When the first trifoliate leaves were fully expanded, the seedling of each cultivar were inoculated by spraying the lower and upper leaf surfaces of the leaves with a spore suspension of a 2-week old culture of the pathogen at a concentration of $1.2x10^6$ spores/ml.

Inoculated seedlings were placed in humid chambers with 85-100% relative humidity and temperature between 18-25°C until scoring was done seven days after inoculation. The reactions of the differentials were recorded using a 1-9 scale where 1 = no visible disease symptoms and 9 = severe necrosis on 25% or more of the plant tissues which often results in death of much of the plant tissues. A binary system was used to determine races (Barrus 1918, Goth & Zaumeyer 1965, Tesfaye 1991), where plant reaction was considered resistant if the score was 1-3 or susceptible if it was 4-9 (Table 1). A binary value is given when a variety is susceptible. Reaction of differentials was determined under green house condition at Ambo Plant Protection Research Center.

Table 1. Designation of races of *C. lindemuthianum* uses 12 differential cultivars.

Variety/differentials	Value number of varieties when susceptible	*A	*B	*C	*D
Michelite	1	S(1)		(S)1	(S)1
MDRK	2		(S)2	(S)2	(S)2
Perry Marrow	4	S(4)			(S)4
Cornell 49242	8		(S)8	(S)8	(S)8
Widusa	16				(S)16
Kaboon	32	S(32)	(S)32		(S)32
Mexico 222	64			(S)64	(S)64
PI 207262	128		(S)128		(S)128
To	256				(S)256
Tu	512				(S)512
AB 136	1024				
G 2333	2048				
Race Denomination		37	168	75	1023

* *Isolates*

Results

The reactions of the 12 differential cultivars to all isolates of *C. lindemuthianum* collected from Ethiopia indicated the presence of 14 races of the pathogen in the country. Two of them (races 128 and 511) were frequently occurring in the surveyed areas (Table 2).

Similar races (128 and 511) were found at Meki and Ziway in all the seasons. Some differential cultivars, namely MDRK, PI 207262, To and Tu reacted similarly to Bako isolates and PI 207262 to Ziway isolates in the same year. whereas, Ambo and Awassa isolates showed different reactions in the same year.

Although the method of inoculation gave similar results, seedlings seemed more responsive to the method of Giessen and Steenbergen (Giessen & Steenbergen 1957). Only the cultivars AB 136 and G 2333 gave a reaction of 2 and 3 when inoculated with all isolates tested.

Discussion

The number of races detected shows the wide degree of variability within the pathogen population in Ethiopia. The selection and use of differentials need to include cultivars with potential use as source of resistance. Cultivars such as T, Tu, PI 207262, Mexico 222, Kaboon, WIDUSA, Perry Marrow were susceptible to races identified in this study. Race 585 was pathogentic to varieties tu, Mexican 222, Cornell 49-242, Perry Marrow, MDRK and Michelite; whereas race 128 attached only PI 207262. Among the differential cultivars Cornell 49-242 is being used for breeding purpose at the moment. None of the races tested were pathogentic to AB 136 and G 2333 parent.

The "Are" gene present in Cornell 49-242 (Mastenbioek 1960) is the main source of resistance to anthracnose and this gene is present in many North American and some of Brazilian cultivars. The detection of race 511 and 128 on farmers' seed indicates the presence of potential danger in the extensive use of Are-gene in Ethiopia. This study also shows a widespread occurrence of the two races (128 and 511) in the country, which constitutes about 60% of the total isolates. Although anthracnose is prevalent in all bean-producing areas of Ethiopia, some races of *C. lindemuthianum* have limited distribution. Ethiopian farmers could attribute this to the use of locally available seeds.

This study has revealed the existence of pathogenic

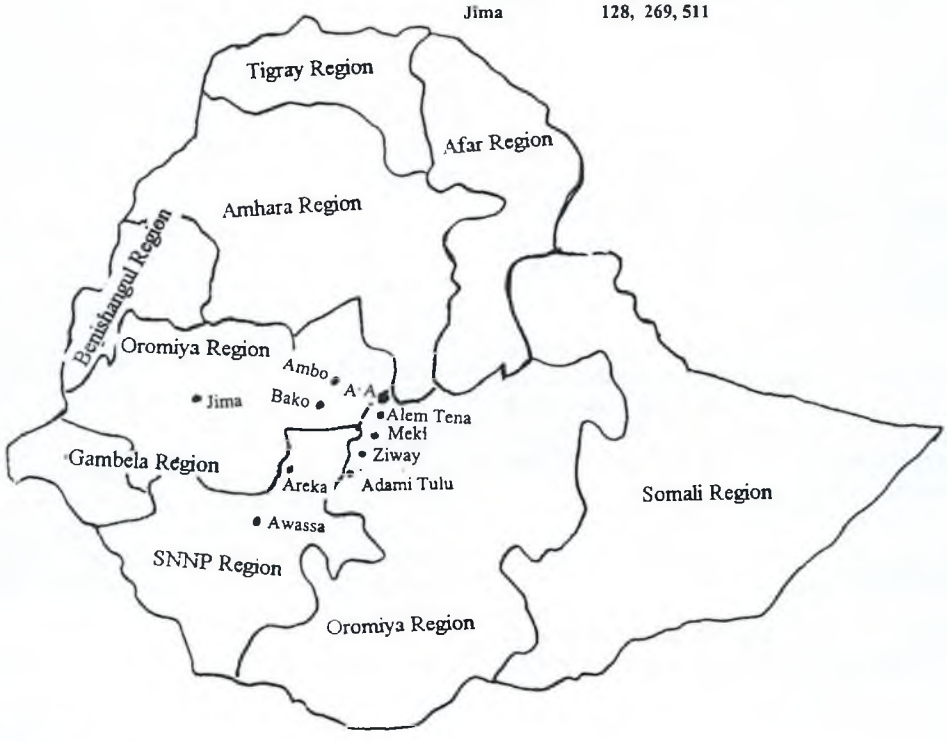
variability within pathogenic population of *C. lindemuthianum* in Ethiopia. It was difficult to compare our results which is based on binary system with the previous one, because reports from earlier works on race identification of anthracnose pathogen was based on nomenclature that was using Greek alphabet (alpha, gamma, beta, etc.). Nevertheless, from results, it can be seen that there are as many as 15 races identified in the country (Table 2). This implies that the anthracnose pathogen in Ethiopia has very diverse isolates possibly in their pathogenicity. There could also be new races of the pathogen in the country. Gathuru (1991), for instance, reported that nine of the pathogen's isolates he collected in Kenya were different from any of the races known in the world, so far.

Races 511 and 128 occur in the locations surveyed and seem to be the more prevalent races of the pathogen in bean growing regions of Ethiopia than others do. Whereas, races 1,525,585,1009,961,898,906,499,1011,718,712,952, and 269 have limited distribution. Future national bean improvement program should focus on incorporation of resistance genes against races 511 and 128 in a single variety through breeding effort; while for the other races with limited distribution (Table 1), specific breeding can be undertaken.

To get a complete picture of the race situation in the country, extensive work on race identification should be done in the future to cover more beans growing areas, which were not covered in this study. Differential cultivar Cornell 49-242 was found immune to all isolates whereas Kaboon was susceptible to the majority of the isolates. Gathuru (1991) reported similar result.

Key: Races found in different locations of Ethiopia

Ambo	1, 128, 511, 525, 586
Awassa	128, 511, 961, 1009
Bako	128, 511, 898, 906
Ziway	128, 511
Areka	128, 499, 511, 1011
Adami Tulu	128, 511, 712, 718
Meki	128, 511
Alem Tena	128, 511, 952
Jima	128, 269, 511



Map 1: Distribution of races of Colletotrichum lindemuthianum

Table 2. Races of *Colletotrichum lindemuthianum* identified in different locations of Ethiopia, 1992-95

Location	1992		1993		1994		1995	
	Isolate Collected	Races Identified	Isolates Collected	Races Identified	Isolate Collected	Races Identified	Isolates Collected	Races Identified
Ambo	5	252,1	4	585	4	525,585	2	525,858,1,128,511
Awassa	5	1009	5	1009,961	6	1009,961	4	1009,961,511,128
Bako	6	898,906	5	906	6	898,906	3	898,906,128,511
Ziway	5	128,511	5	128,511	5	128,511	4	128,511
Areka	5	499	5	1011	3	499,1011	4	499,1011,128,511
Adami Tulu	3	718	4	712	3	718,712	3	718,712,511,428
Meki	6	511,128	7	511,128	6	511,128	4	511,128,952,128,511
Alem-Tena	3	952	3	952	2	952	1	952,128,511
Jimma	6	-	6	269	4	269	4	269,128,511

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