Screening Common Bean (*Phaseolus vulgaris* L.) Germplasm for Resistance against Angular Leaf Spot (*Pseudocercospora griseola*) Disease under Field Condition

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Abstract

Angular leaf spot (ALS) caused by the fungus *Pseudocercospora griseola* is one of the most destructive disease in Latin America and eastern Africa countries. The fungus, *P. griseola* is highly variable and a diverse sources of resistance genes is required to manage this economically important disease. The use of genetic resistance is the most practical and economic way to manage angular leaf spot of the common bean. Common bean (*Phaseolus vulgarise* L.) germplasm were screened for resistance against Angular leaf spot (ALS) under field conditions at Wonodogenet and Areka Research farms. Out of 300 common bean accessions evaluated only 14 (4.6%) common bean accessions were resistant to naturally epidemics of angular leaf spot disease under field condition. Therefore, all common bean germplasm that showed resistance reaction can be involved in breeding program for the improvement of the common bean.

Keywords: screening, angular leaf spot disease, disease reactions

1. Introduction

Common bean (*Phaseolus vagaries* L.) one of the most important pulse crop in terms of nutrition, food security and economy, is cultivated in different regions of Ethiopia (Lemessa and Tessfaye, 2005). Among the most cause of poor yield in common bean production includes fungal, bacterial and viral diseases (Ferreira et al., 2003; Rezene et al., 2018). Angular leaf spot caused by *Pseudocercospora griseola*, may induce up to 40 to 80% yield loss when a susceptible variety is grown in a region with cool to moderate temperatures (13-26 ^{0}C) and abundant moisture (Lemessa et al., 2011).

Several strategies can be used to manage angular leaf spot but the use of genetically resistant common bean cultivars is the most effective controlling measures farmers to adopt (Pastor-Corrales et al., 1998; Schwartz et al., 1999; Wagara et al., 2003). The main drawback to resistant cultivars is the possible breakdown of the resistance caused by adaptation of the pathogen to host resistance (Guzman et al., 1979; McDermott et al., 1993). A number of exotic sources of ALS resistance do exist and have been utilized in breeding programs targeting ALS and the cultivars with sources of resistant includes Mexico 54, MAR1, MAR2, AND277, G5686, G10909 and G10474 (Mahuku et al., 2003; Caixeta et al., 2005). Besides, majority of resistance sources are with a climbing growth pattern; such attributes are not readily accepted by farmers in Africa at large (Beebe et al., 1981) and specifically in Ethiopia. But landraces and introductions with bush type growth habit adapted and maintained by farmers have for a long time been known to have useful agronomic traits. Indeed, most existing resistant sources developed elsewhere, have been derived from landraces (Busogoro et al., 1999). For instance, G5686, which is a good source of ALS resistance and a member of the ALS differential set, is a landrace that originated from Ecuador (Mahuku et al., 2009). Though resistance may exist in bean collections, the high degree of genetic variability of *P. griseola* often compromises the use of ALS resistance derived from landraces (Nietsche et al., 2001). This is due to continuous emergency of new races, which break down disease resistance (Young et al., 1998). Hence, the need for continuous screening of germplasm to identify new sources of resistance that can regularly be introgressed into commercial cultivars (Young & Kelly, 1996). This will counteract the new emerging races and reinforce resistance in existing ALS resistant sources.

Therefore, this screening study was conducted to asses and identify resistant common bean accessions to be used

in the breeding program to develop resistant cultivar.

2. Materials and Methods

2.1 Experimental Site and Design

The experiment was carried out at the Wondogenet and Areka research stations located in southern Ethiopia, respectively at N07''03.968' E037''41.124' and 1803 m.a.s.l and 7° 4′ 0″ N, 37 °42′ 0″ E and 1774 m.a.s.l with an average precipitation 1290mm. These two locations are known for high infestation of the angular leaf spot disease. Both experimental sites were selected based on the basis of history of ALS disease infestation. Hence, the two screening areas are appropriate sites for screening common bean genotypes resistance against angular leaf spot disease. Common bean germplasms were evaluated with 2 rows of 3m length in Augmented design with randomized incomplete design (Lin, & Poushinsky,1983). The materials were evaluated under natural disease epidemics in three different environments. ALS disease severity was recorded at 55 and 66 days after planting using the 1-9 CIAT scale (Van Schoonhoven and Pastor-Corrales, 1987), where 1= no visible symptom and 9= disease covering more than 25% of foliar tissue.

2.2 Plant Materials

A total of 300 common bean germplasm including large world collections lines and varieties and standard checks known for the angular leaf spot resistance genes obtained from different countries of breeding program were included in this study.

2.3 Statistical Analysis

Mean ALS disease scoring data from each common bean germplasm were examined and used for data analysis. Data from ALS disease severity were subjected to analysis of variance using SAS version 3.2 (Lin, & Poushinsky, 1983) using PROC GLM Augmented Micro SAS procedure.

3. Result and Discussion

Existence of highly significant (<1%) variation for the disease severity among common bean germplasm tested under field conditions indicates variability for resistance among the accessions for the angular leaf spot disease under field condition (Table 1, Figure 1). The maximum disease reactions were recorded for most of germplasm. In other study over 1300 bean accessions were screened under field condition for anthracnose and angular leaf sport resistance and among the accessions few of the accessions found to be with resistance reaction (Schwartz, et al., 1982). Based on the current study 15 lines /accessions (Table 2) with resistance reactions to the angular leafspot under the field conditions were selected for further evaluation under greenhouse condition. Out of the accessions Acc#299 a small red seeded bean showed high resistance to the ALS disease at both test locations. Hence, these accessions showing resistance are potential for developing broad and durable ALS resistance

3.1 Implications in Common Bean Breeding

These day's development of cultivars with improved angular leaf spot disease resistance is one of the main goal of common bean breeding programs. The development of resistance cultivar requires best adapted parental lines with known resistance genes. This is due to continuous emergency of new ALS races, which break down disease resistance (Young et al., 1998). ALS race distribution from the bean growing areas of Ethiopia and reaction of common bean genotypes has been studied and reported by Rezene et al., (2018). A wide frequency variation in the differential cultivars were also reported by the same authors. Most of the common bean differentials were compatible to the Ethiopia angular leaf spot races. Hence, the need for continuous screening of germplasm to identify new sources of resistance that can regularly be introgressed into commercial cultivars (Young & Kelly, 1996). Therefore, the selected resistance from the current screening study will be refined and used in the common bean improvement program.

Table 1. Mean square of common bean germplasm under different environment for angular leaf spot disease

		Mean Square			
Source	DF	ALSW16	ALSW17	ALSA17	ALSCOMB
Block	5	0.2222NS	0.0889NS	2.2805NS	0.1343NS
Treatment	299	3.6484**	2.1019**	1.775**	1.1673**
Tests	287	2.2176**	1.71875**	1.4911**	0.8698**
Controls	11	32.7676**	11.4076**	9.3169**	6.2456**
Tests vs Controls	1	94.0444**	9.7187**	0.2007**	23.6903**
Error	55	0.2101	0.0888	0.8806	0.0891
*- significant at 5% (level of significance) NS=Non-Significant					
p-Value <0.05%- Significant at 5%(*), p-Value <0.01-Sigifican 1%(**)					
R-square	0.99	0.99	0.92	0.99	
CV	8.47	5.99	19.33	5.92	
ALS Mean	5.41	4.07	4.85	5.04	

DF=degree freedom, ALSW16= angular leaf spot from Wondogenet during 2016, ALS W17 =angular leafspot from Wodogenet during 2017, ALSA17= angular leaf spot from Areka during 2017.

Table 2. Common bean germ plasm that showed resistance reaction under field condition at Wondogenet (ALSW16 &ALS17) and Areka (ALSA17), Ethiopia during 2016 and 2017 cropping seasons

		ALSW16	ALSW17	ALSA17	ALSCOM		
Accessions	Genotype	ALS Adjusted mean score (1-9)				Growth habit	Seed colour
Acc#272	KG27-13	1.8	3.1	3.2	2.1(R)	VINE	RED M
ACC#269	GCI-CAL-270A	1.8	2.4	4.2	2.6(R)	BUSH	RED M
Acc#100	NABE4	3.0	1.6	2.7.	2.7(R)	BUSH	RED M
Acc#181	AFR612	2.1	2.7	3.7	2.7(R)	BUSH	RED M
Acc#194	SAB618	3.1	2.9	2.7	2.9(R)	BUSH	RED M
ACC#98	CHEUPE	2.0	2.2	4.2	3.0(R)	BUSH	WHITE
Acc#183	AND279	2.1	1.6	5.2	3.0 (R)	BUSH	RED M
Acc#255	SUGER131	1.0	3.1	5.7	3.0(R)	VINE	CRANS
Acc#86	MISHINDI	2.0	2.9	3.7	3.1(R)	BUSH	GREY
Acc#142	AW-SPS-51	2.0	2.9	2.4	2.6(R)	BUSH	S RED
Acc#188	DAB246	3.1	4.9	1.2	3.1(R)	BUSH	RED M
Acc#268	UYOLE	3.8	3.1	5.2	3.1(R)	BUSH	RED M
Acc#185	ROZO KOBO	3.1	4.9	1.7	3.2(R)	BUSH	RED M
Acc#95	TYGER BERG	5.0	3.7	1.7	3.4(R)	VINE	CRANS
Acc#299	SPS50-HB	1.2	2.4	1.7	1.8(R)	BUSH	RED S
Standard Checks							
MEX-54		3.0	2.9	1.7	3.4(R)	VINE	Pink
AND277		1.3	2.3	3.2	2.1(R)	BUSH	REDM
CV		7.2	9.2	19.3	5.9		
LSD		5.41	4.07	4.85	5.04		

ALS disease evaluations using a 1 to 9 rating scale, where 1 = no visible symptoms of the disease and 9 = very severe symptoms (Schoonhoven & Pastor-Corrales, 1987). ALS reaction type: 1–3 = resistant (R); 4–6 = intermediate (I); 7–9 = susceptible (S), here we have selected those genotypes showing resistance(R) reactions to the angular leaf spot under field condition.
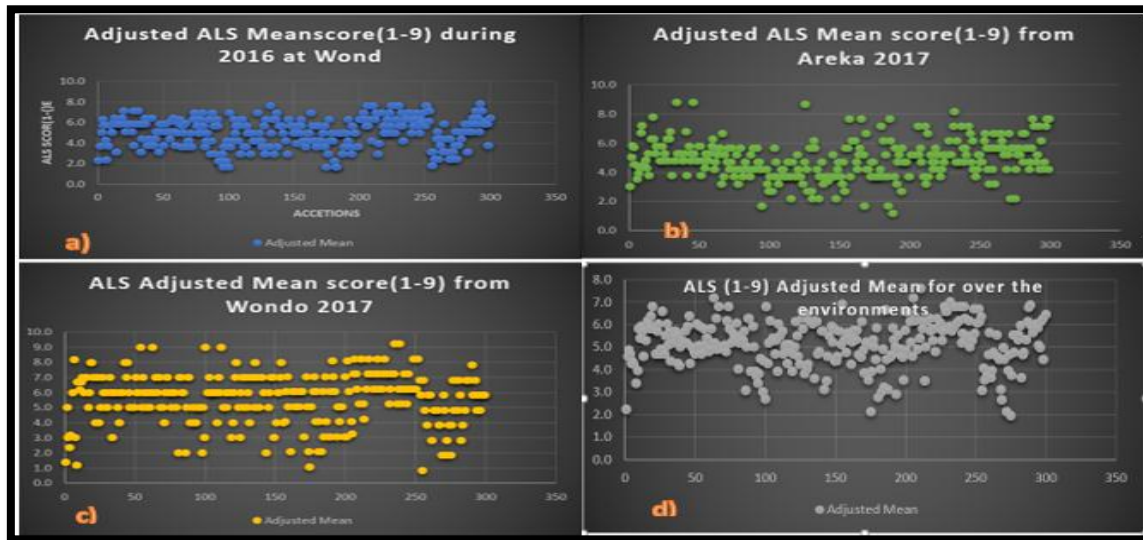
Figure 1. Adjusted mean disease severity score (1-9) for 300 common bean germplasm a) at Wondogenet 2016, b) Areka 2017, c)Wondogenet 2017 and d)the reaction across all environment. Accession their adjusted mean scores under 4 were all with resistance reaction to the naturally epidemic angular leaf spot disease
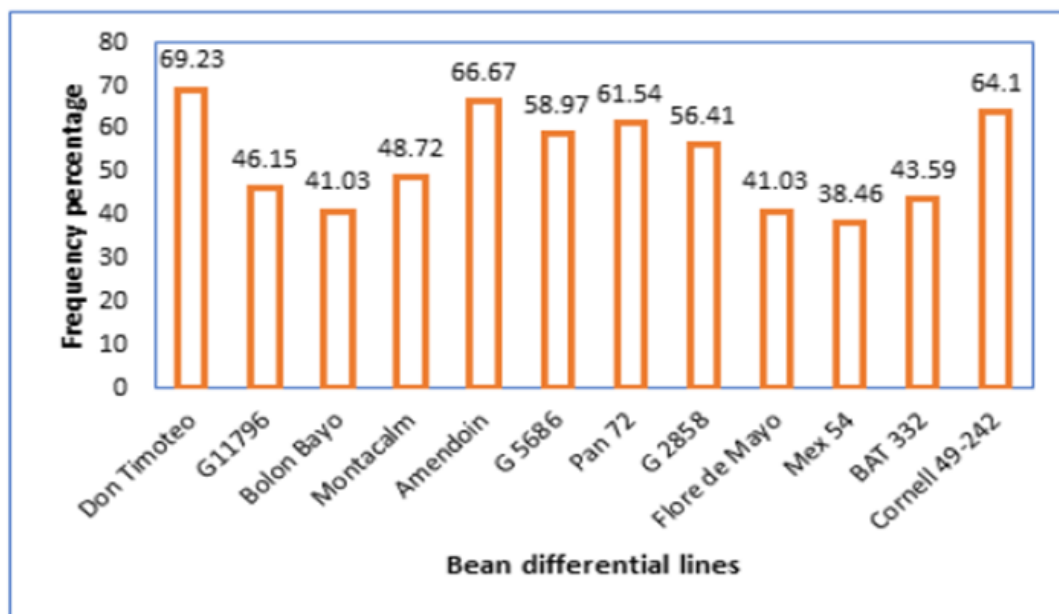

Figure 2. Frequency (%) of compatible reaction between sets of differential common bean genotypes and evaluated isolates

Source: Rezene et al., 2018

Acknowledgement

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