

Research Article

Reaction of Promising Illu-Ababor Coffee Selections Against Major Coffee Diseases

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Abstract

Coffee is prone to a number of diseases that attacks berries, leafs, root and stems reduce the yield and marketability. Among diseases Coffee Berry diseases (CBD), Coffee leaf rust (CLR), Coffee wilt diseases (CWD) are the major diseases in Ethiopia. The study was contained 13 coffee selections collected from different coffee producing areas of illu-ababor zones with four resistant checks (754, 7410, 744 & 7440). These selections were planted at Metu Agricultural Research Sub center (MARC) Gore and Chora trial sites in RCBD during 2010 cropping year. Significant difference among the genotypes for coffee berry diseases was observed specially at CBD prone site Chora. Severity values of selections ranged from 0.00 – 51.27% and among selections 229/71(3.00), p-23(8.55 showed below 5% severity at Chora and promoted to attached berry test. As the result in the (Table 1) indicates, the coffee accession 229/71(0.47)% showed highly resistant reaction to coffee berry disease and selected for further breeding purposes. While, 678 (51.27), revealed 50% susceptible reaction for both visually and by attached berry test to CBD. The selections were showed highly resistant reactions (744,754, P-23, P-30) 0.13, 0.16, 0.66 and 0.88 respectively and the remaining were showed moderately resistance reaction to coffee leaf rust at three locations. The seedling test result indicates that two coffee selections (P-30) and (P-23) 17.7% and 21% moderately resistant reaction and the rest coffee selections showed susceptible reaction to coffee wilt diseases.

Keywords

Disease Resistant, Colletotrichum Kahawe, Geberella Xylarioides, Hemileia Vastatrix, Seedling Death Rate, Incubation

1. Introduction

Coffee is the most vital sources hard currency crop, more than 125 million people around coffee growing areas derive their livelihood directly or indirectly from Arabica Coffee worldwide [1]. It has contributed about 10% of total foreign exchange earnings in the continent. The sub-Saharan African countries, including Ethiopia, Uganda, Kenya, Rwanda and Burundi, depend on coffee export for more than half of their foreign exchange profits [2]. In Ethiopia, coffee farming pro-

vides an income for around 16% of the growers [3, 4], 4% domestic product (GDP), 10% agricultural production and about 37% of total export earnings.

However, coffee production is challenged by several a biotic and biotic entities that limits the income gained from coffee. Commonly, *Colletotrichum* species that cause anthracnose symptoms are reported in several African countries [5]. Coffee berry disease (*Colletotrichum kahawae*), coffee

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wilt disease (*Gibberella xylarioides*) and coffee leaf rust (*Hemileia vastatrix*) attacking fruits, leaves, stems and roots, have been reported as serious challenges of coffee production in tropical and subtropical coffee growing areas [6].

C. kahawae is an aggressive and specialized fungal pathogen which has great impact on the green berries (economic parts) and becomes big concern in Africa [7, 8]. The losses due to CBD on individual farms vary considerably. Under conditions where no control measures are undertaken, the losses can be reaching up to 100% in high rainfall and altitude areas [7].

Starting from its occurrence, different research findings have been done on its importance at different growing areas of Ethiopia. [9] Reported 52.5% and 29.9%, national average incidence and severity respectively. However, the overall national average yield loss due to CBD is estimated between 25 to 30%, [10, 11].

Coffee leaf rust (CLR) is the main disease affecting coffee worldwide. It is caused by *Hemileia vastatrix* (*Pucciniaceae*) which is a host-specific obligate parasite [12, 13]. It attacks the coffee leaves reducing the photosynthetic area and leading to defoliation and occasionally causing branch dieback and even to plant death. High incidences of CLR can cause the loss of up to 50% of the foliage and up to 70% of berries – leading to yield reductions of 30% to 50% [14, 13]. Recently economic losses reaching up to 90% have been reported in some Central American countries due to epidemic of CLR [12].

Coffee Wilt Disease (tracheomycosis) is a vascular disease caused by the fungal pathogen, *G. xylarioides* (*F. xylarioides*) and results in a total death of the infected coffee trees. The highest percentage was recorded in, Berhane-Kontir 78–98 and Bonga 60–97 during the period of assessments of the disease in 2004–2006 G. C [15].

Therefore, great emphasis must be given to minimize the risk this disease in the country. There are great deals that using resistant varieties play a significant role in combating CBD [16]. As well, agro ecological based local landraces development is very important to utilize the available genetic resources found in different coffee growing areas of the country [17, 18].

Jimma Agricultural Research Center (JARC) has been playing a crucial role by developing and releasing improved coffee varieties adapted to different agro ecologies with the focus of local landrace development to alleviate CBD problem [19]. The center has developed 44 CBD resistant varieties for different coffee producing areas [20]. However, this research direction lacks to provide varieties that are suitable for Illu-ababor zone in the southwestern parts of the country. Recently, Jimma Agricultural Research Center collected 13 coffee landraces from major coffee producing areas (Gore, Chora, and Metu districts) of Illu-ababor zone and planted at Gore, Chora and Metu Agricultural Research Sub Center for detail study on the reaction performance the collections for CBD, CLR and CWD resistant coffee varieties for Illu-

ababor Coffee producing areas.

2. Material and Methods

2.1. Description of the Study Area

The experiment was conducted at Metu agricultural research sub-center of Jimma agricultural research center. The sub-center is located at a distance 3 km from Metu zone and 272 km from Jimma agricultural research center 8° 19' 0" to North and 35° 35' 0" to East. The area has an Altitude 1558 m. a. s. l. and with annual rainfall 1829 mm and minimum and maximum temperature 12.7 °C and 28.9 °C, respectively.

2.2. Treatments and Design Used

The study was contained 13 coffee selections collected from different South-western Ethiopia with four resistant checks (754, 7410, 744 & 7440). These selections were planted at Metu Agricultural Research Sub center (MARC) Gore and Chora sites 10 trees/plot and 2 m x 2 m spacing (between treatments) in RCBD design during 2010 cropping year. The overall disease pressure (CBD incidence) was assessed on each individual selections using visual scale score (0-100%) for consecutive 5 years. Then, after computing the mean CBD incidence and severity, the promising selections showed better (lower) CBD infestation in the visual score, were tested using via attached berry test (ABT). Visual assessment (0-100% scale score) of Coffee leaf rust was conducted to estimate the level of Coffee leaf rust under field conditions.

2.3. Evaluation of Coffee Selections for CBD Via Attached Berry Test

ABT was carried out on six coffee selections selected based on CBD infection percentage (resistance reaction) in the visual score (under section 2.2) using the procedure adopted by [7]. The main intention of this study was to verify their levels of resistance by artificial inoculation. Briefly, 3 representative trees/ plot and 3 strata (top, middle and bottom canopies) from each tree were selected. Then, the inoculum was prepared using 2×10^6 standards. After tagging each selected strata, the number healthy berries on each strata was counted and inoculation was done by hand sprayer. To favour infection, inoculated strata were covered with plastic sleeves with paper bags for 24 hrs. Three weeks after inoculation (WAI), the number of healthy and infected berries per strata were recorded and finally percentage infected berries was calculated as follows (1):

$$\text{Disease severity (DS)} = \frac{\text{Number of infected berries}}{\text{Total number of berries on the strata}} \times 100 \quad (1)$$

Statistical analysis

All the disease data collected in the resistance evaluation

studies were analyzed using ANOVA (SAS version 9.3) software packages and treatment means were compared using Duncan Multiple Range Test (DMRT). Before analysis of variance, all data sets were tested for normal distribution using the normality test and ANOVA was performed for field and greenhouse data.

3. Result and Discussions

Coffee berry diseases: Thirteen coffee Arabica selections were evaluated for their resistance against coffee Berry disease (CBD), coffee leaf rust (CLR) and coffee wilt disease (CWD) in 4 consecutive years under field and glasshouse condition. The mean result revealed that significant difference among the genotypes for coffee berry diseases. Of which, the CBD severity values on 13 selections ranged from 0.00 – 51.27% and among selections 229/71(3.00), p-23(8.55) showed below 10% severity at Chora. While, 678 (51.27), revealed 50% susceptible reaction for CBD (Table 1). But most of coffee selections at three locations showed resistant reactions. This is because of the three locations are not similar Agro-ecology, the Altitude, the rainfall; temperature and the vegetation cover are different. For example Gore is the highest Altitude and receiving high rainfall annually which is represent highland, but Metu represent the mid-altitude and Chora is from mid- to high attitude area of Ilu-ababor Zone. [11] Indicated that the main driving factors for the occurrence, distributions and Aggressiveness of coffee berry diseases are high altitude, high rainfall with pocket areas and under deep shades. Based on the three years visual data, attached berry test was done on two selections including the resistant checks which showed resistant reaction at Chora. The result revealed that the two selections 229/71 and P-23 resistant reaction (0.47) % and (5.31) % to coffee berry disease respectively.

Coffee Leaf Rust: Ilu-ababora coffee selections were evaluated for coffee leaf rust. Most of the selections were showed resistant to moderately resistance reaction at three locations. This could be because of intensive management made such as pruning, nutrient amendment, and appropriate shade. [21] Reported that Coffee leaf rust intensity is higher in lower altitude and lower in higher altitudes. Besides, coffee fields planted with improved varieties and good management had lower.

Table 1. Mean three years reaction of Ilu-ababor coffee selections for coffee berry disease and Coffee leaf rust.

Acno	Chora			Gore		Metu	
	CBD	ABT	CLR	CBD	CLR	CBD	CLR
678	51.27	-	1.17	9.00	0.50	5.83	2.76
227/71	32.70	-	3.18	9.92	2.68	2.70	3.18

Acno	Chora			Gore		Metu	
	CBD	ABT	CLR	CBD	CLR	CBD	CLR
p-30	29.47	-	0.88	0.42	0.67	0.00	1.90
p-17	28.85	-	2.33	1.39	0.82	8.33	2.27
236/71	28.53	-	1.74	6.39	1.95	0.31	0.98
p-28	27.39	-	1.91	1.53	1.35	4.17	2.31
p-16	25.80	-	4.05	2.97	0.76	0.00	5.66
363/73	25.38	-	1.67	0.28	0.91	0.20	4.56
8/72/74	23.99	-	1.42	3.14	1.52	0.03	2.57
243/71	23.82	-	5.69	3.47	0.58	0.03	4.03
233/71	19.99	-	4.47	3.89	1.34	0.42	4.42
p-23	8.55	5.31	0.64	1.72	1.32	0.00	2.31
754	3.32	1.52	0.33	0.00	0.78	3.50	1.15
229/71	3.00	0.47	1.74	0.03	0.85	3.83	0.82
74110	2.33	0.47	1.33	0.14	1.20	0.14	2.61
74140	1.78	1.81	2.16	0.03	0.48	0.17	4.68
744	1.55	2.27	0.16	0.00	0.45	0.00	4.01
Mean	19.86	1.69	2.05	5.61	1.07	3.74	2.95
LSD	16.18	0.92	1.73	4.89	1.30	3.95	1.49
CV (%)	49.30	34	47.50	45.08	38.63	49.95	27.09

ABT=attached berry test, CWD=coffee berry disease, CLR=coffee leaf rust.

Coffee Wilt Diseases: Ilu-ababor Coffee selections including Lab resistant checks were tested for Coffee Wilt diseases in glasshouse at Jimma Agricultural Research center. The seedling test result indicates that two coffee selections (P-30) and (P-23) 17.7% and 21% moderately resistant reaction and the rest coffee selections showed susceptible reaction to coffee wilt diseases. At field the stand count at the three locations made. The percent of wilting symptoms or dead trees were from (60 -90) % survival rate recorded which shows resistant to moderately resistant reaction to Coffee wilt disease at field condition especially at Metu site which is Coffee wilt disease prone areas.

Table 2. The reactions of coffee genotypes for coffee wilt disease under greenhouse and field conditions.

Genotypes	Mean CWD in (%)	(%) of Field Survival rate at three locations
Gesha	83a	-
744	72ab	90

Genotypes	Mean CWD in (%)	(%) of Field Survival rate at three locations
p-17	66.7abc	48
678	55.7bcd	70
754	55.3bc	70
233/71	53bc	70
363/73	50.7bcd	60
74110	50bc	70
236/71	48.3bc	60
229/71	47bc	90
8/72/74	46.7bc	60
227/71	45.bc	80
243/71	42c	90
p-16	41.c	90
74140	39.7c	90
p-28	37c	80
p-23	21cd	80
p-30	17de	80
370	8.67f	-
2/79*	6.f	-
Mean	44.9	
LSD	25.68	
CV (%)	14.12	

Summary and Recommendations

Ethiopia is ecologically very diverse and coffees grown under these environments are different in quality, diseases resistance yield potential and many other traits. A new breeding strategy known as 'Local landrace coffee breeding Variety development program' was designed with main objectives to develop high yielding and diseases resistance cultivars with good quality for major coffee growing areas of Ethiopia [22]. A total of 124 coffee accessions were collected from different coffee growing areas of Illu-ababor zone in different batches. Among these 13 genotypes were verified at three locations (Gore, Metu and Chora) and have been evaluated for major diseases by visual and laboratory inoculation methods.

There were significant differences among Illu-ababora coffee genotypes evaluated for resistance to coffee berry diseases (*Colletotrichum kahawae*) at three locations. The average severity of was from 51.27 – 3.55 percent, 9.92 – 0.00 percent and 5.83 – 0.00 percent recorded at Chora Gore and Metu respectively. The attached berry test was made among the genotypes those visually showed resistant reaction at hot spot area (Chora) trial site and the genotype 29/71 confirmed resistant reaction and selected for further study.

Significance reactions among coffee genotypes were also observed for coffee leaf rust and coffee wilt diseases. The selections were showed resistant to moderately resistance reaction for Coffee leaf rust at three locations. The seedling test result indicates that two coffee selections (P-30) and (P-23) 17.7% and 21% moderately resistant reaction and the rest coffee selections showed susceptible reaction to coffee wilt diseases. At field the stand count at the three locations made. The percent of wilting symptoms or dead trees were from (35 -90) % survival rate recorded.

Abbreviations

CBD	Coffee Berry Disease
CWD	Coffee Wilt Disease
CLR	Coffee Leaf Rust

Authors Contribution

Gabisa Giddisa: Conceptualization, Data curation, Formal Analysis

Hailu Negasa: Data curation

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Conflicts of Interest

The authors declare no conflicts of interest.

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