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Research Article

Evaluation of Common Bean (*Phaseolous vulgaris* L.)Varieties for the Reaction of Common Bean Anthracnose (*Colletotrichum lindemuthianum*) at Sirinka, Eastern Amhara, Ethiopia

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ABSTRACT

Common bean (*Phaseolous vulgaris* L.) is the most important food legume consumed as source of protein and cash crop in Ethiopia. The production of the crops is constrained by biotic and abiotic factors. Common bean anthracnose caused by the fungus *Colletotrichum lindemuthianum* is a major production constraint in common bean growing regions of Ethiopia. Field experiment was conducted at Sirinka Agricultural research center during 2017/18 main cropping season to evaluate reactions of common bean varieties to the disease. The experiment consisted of twenty two common bean varieties evaluated for the reaction to anthracnose under natural infestation conditions. The highest disease severity (58%) was recorded from Awash-1 variety while the lowest disease severity (45%), was recorded from Awash Melka variety at final assessment day. The highest (3.03 t ha^{-1}) yield was recorded from Awash Melka variety while the lowest (0.97 t ha^{-1}) yield was recorded from KAT-B1 variety. From the present study, it is possible to conclude that, the advantage of screening resistant verities increases the opportunity to select for a broad range of anthracnose resistance and help to know the variability of the common bean anthracnose disease.

Keywords: Anthracnose; Common bean; Variety

INTRODUCTION

Common bean (*Phaseolous vulgaris L.*) is the most important food grain legume consumed worldwide [1]. It is grown and consumed principally in developing countries in Latin America, Africa, and Asia. Its production in sub-Saharan Africa is around 3.5 metric tons $ha^{-1}$with 62% being produced in East African countries namely Burundi, DR Congo, Ethiopia, Kenya, Rwanda, Tanzania and Uganda [1]. The crop is grown worldwide for its edible, dry, fresh and green beans. Production is expanding slowly based on population growth with highest usage in poor developing countries, where beans provide an alternative to meat as a source of low-cost protein. The crop is well suited to low input systems as they can be stored for long periods without refrigeration and provide an excellent nutritional complement [2].

Common bean is an important legume crop in the daily diet of more than 300 million of the world's population [3]. It has been rated as the second most important source of human diet and the third most important source of calories of all agricultural commodities produced in eastern Africa [4]. In Ethiopia, common bean is mainly cultivated in the Eastern, Southern, South-western and Rift Valley Regions [5,6]. The average white and red common bean productivity is 1.41 and 1.56 t ha^{-1} respectively. It is predominantly produced in Oromia region, SNNPR and Amhara region with their area coverage of 146,452.41 ha (41%), 117,969.97 ha (33%) and 81,235.07 (22.74%) ha respectively and the rest 3.25% is produced in other regions of Ethiopia [7]. The crop is a good source of income for small-scale farmers and fetches higher prices than cereals in the local market.

The low yield of the crop could be attributed largely to low adoption of improved agricultural technologies, drought, diseases and insect pests, lack of improved varieties, poor cultural practices and shortage of land and environmental degradation. From those constraint diseases are known to be the major factors affecting the production, productivity and the quality of the crop [8]. Common bean is attacked by a wide range of diseases that affect leaf, stem, root and seed. The major diseases that are affecting common bean production in Ethiopia include anthracnose caused by *Colletotrichum lindemuthianum*, rust caused by *Uromyces appendiculatus*, common bacterial blight caused by *Xanthomonas*

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axonopodis pv *phaseoli*, halo blight caused by *Pseudomonas syringae* pv. *phaseolicola*, angular leaf spot caused by *Phaeoisariopsis griseola*, Ascochyta blight caused by *Ascochyta phaseolorum* and common bean common mosaic virus [5,9]. Among them, Anthracnose caused by *Colletotrichum lindemuthianum*), is a destructive disease worldwide [10].

Before a decade common bean is not well distributed in eastern Amhara, although, the area is potential for common bean production. At present time, the production and area coverage area of common bean has been increasing from time to time because of the fact that the crop has immense potential for export and risk aversion in drought prone lowland areas of Wollo. However, intermittent drought, bean stem maggot, foliage beetle larvae, CBB, ALS and anthracnose have limited productivity of common bean in the lowland areas of Wollo [11]. Although management practices can improve the productivity of common bean in such marginal areas, more progress in improving yield will be realized through genetic improvement [12].

Anthracnose is one of the most serious diseases attacking common bean in cool weathers in Ethiopia. The infected seeds are the most important means of *Colletotrichum lindemuthianum* dissemination, which explains its worldwide distribution [13]. The crop is vulnerable to attack by the pathogen at all growth stage of the crop, from seedling to maturity, depending on the environmental conditions that are essential for the initiation and further development of the disease. Common bean anthracnose causes an estimated yield loss of up to 63% in Ethiopia [14-16]. Previously, Mohammed and Somsiri [17] reported that the intensity of anthracnose on white type common bean was higher in Ethiopia.

The first step for the management of seed-borne diseases is generally to eradicate or reduce the pathogen inoculum in the seed production field [18]. Seed treatment is an important measure for the control of anthracnose [19]. Moreover, utilization of resistant varieties has been the best way to manage the disease, it is one of the most economical and effective methods of anthracnose management [20].

The chemical control should form part of disease management practice and applications of contact or systemic foliar fungicide are the most important for the management of bean anthracnose [15]. Fitsum [21] reported that the possibility of using Flopan as foliar spray and *Pseudomonas fluorescens* as seed treatment, decreased anthracnose disease symptoms effectively in common bean plants and increased seed yield under field conditions. Recent studies showed that integrated management of crop diseases is getting increased attention as an environmentally sound approach.

Although the effect of common bean resistant and susceptible varieties to minimize the yield losses of anthracnose, it has received comparatively little attention in the Northeastern Ethiopia. Moreover, the reaction of commonly released common bean varieties to the disease is not well known in the area. Therefore, the objective of this study was to evaluate the effect of common bean varieties for the reactions of the disease.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at Sirinka Agricultural Research Center experimental site located at (11°45'00'' N latitude; 39°36'36''E longitude; 1850 meters above sea level in northern Ethiopia during 2017main cropping season (July to October). The soil of the experimental fields is clay loam and clay with the pH of 6.9-7.23. The organic carbon is 1.37%, total N is 0.09%, available P 12.17 mg kg-1 soil and CEC 53.44 c molc kg^{-1} [22]. The total amount of rainfall is 750.4 mm with mean maximum and minimum temperatures of 28.6 and 14.7°C, respectively.

Experimental design and treatments

Experiments were conducted with natural infestation, during 2017 to evaluate the reaction of 22 bean varieties including resistant and susceptible check to bean anthracnose. Common bean varieties used in the experiment and their characteristics is indicated in Table 1. The treatment was arranged in a Randomized Complete Block Design (RCBD) with three replications. Spacing between plants and rows were 10 cm and 40 cm, respectively. There were 66 plots, each consisting of 2 rows. Spacing between blocks was 1 m and between adjacent plots 0.5 m. Each row had 20 plants. In general, there were 40 plants per plot in which ten of them were randomly pre-tagged from the two rows. Seeds was planted at the rate of two seeds per hole and thinned to one plant, 15 days after sowing (DAS) to ensure 40 plants per plot. All agronomic practices were performed uniform for all plots of each treatment.

Data collection

Disease assessment: Anthracnose severity was assessed every week after the onset of the disease. Ten plants were randomly selected and tagged from central rows of each plot and were used to determine the disease severity. The severity of anthracnose on the pre-tagged common bean plants was estimated six times as the area of plant tissue damaged using a 1-9 rating scale, as follows:1= no visible disease symptoms; 3= presence of very small lesions, mostly on the primary vein of leaf's lower side or on the pod, that covers approximately 1% of surface area;5= presence of several small lesions on the petiole or on the primary and secondary veins of the leaf's lower side or small round lesions on the pods, with or without reduced sporulation, that covers approximately 5% of the pods surface area,7= presence of enlarged lesions on the lower side of the leaf. Necrotic lesions can also be observed on the upper leaf surface and on the petioles. On the pods, the presence of medium lesions are evident but also some small and large lesions generally with sporulation and that cover approximately 10% of the pod's surface area may be found and 9= more than 25% of the leaf surface area covered with large coalescing and generally necrotic lesions resulting in defoliation [23]. The severity scores were then converted into Percentage Severity Index (PSI) according to the formula by Wheeler [24].

$$\text{PSI} = \frac{\text{Sum of numerical rating} \times 100}{\text{Number of plants scored} \times \text{Maximum score on scale}}$$

Area under disease progress curve and disease progress rate: The Area under Disease Progress Curve (AUDPC) was computes from the PSI data was record at each date of assessment as describing by Campbell and Madden [25].

$$\text{AUDPC} = \sum_{i=1}^{n-1} 0.5(x_{i+1} + x_i)(t_{i+1} - t_i)$$

Where 'n' is the total number of assessments,' t_i' is the time of the ith assessment in days from the first assessment date, 'x_i' is percentage of disease severity at i^{th} assessment. AUDPC is expressed in percent-

Table 1: Common bean varieties and its characteristics.

Varieties	Seed color	Seed shape	Amount of Rain fall	Days of maturity	Year of release	Altitude (m.a.s.l)	Suitable production area
Awash Melka	White	Flat	350-700	85-100	1999	1400-1900	All Ethiopia
ICB-0081	Mottled	Kidney	400-100	90-95	2013	1400-200	Middle Rift Valley and south
Nazareth-2	White	Elong	350-1000	90-95	2005	1330-1850	Middle Rift Valley
Tabor	Pinto	Elong	1000-1300	98	1999	1300-1900	Southern Ethiopia
Ser-125	Red	Elong	450-700	85-100	2014	1450-2000	Middle Rift Valley
KAT B9	Red	Round	1400-200	85-90	2013	1400-200	Middle Rift Valley
SAB-736	White	Elong	400-750	85-90	2015	1500-1800	Middle Rift Valley, South and Harrga
Argene	White	Elong	350-1000	90-95	2005	1300-1800	Middle Rift Valley
ser-119	Red	Elong	450-700	85-100	2014	1450-2000	Middle Rift Valley
KAT-B1	Yellow	Round	500-1500	75	2013	1500-1800	Middle Rift Valley
Biofort (Large 5)	Mottled	Elong	400-750	89	2016	1500-1800	Middle Rift Valley
Awash-2	White	Round	400-750	85-90	2013	1300-1700	Middle Rift Valley and the same place
Nasir	Red	Elong	350-1000	86-88	2003	1200-1800	All Ethiopia
Ibado,	Motteled	Elong	350-500	90-120	2003	1400-2250	Southern Ethiopia
Duristu	Red	Elong	750	85	2008	1300-1800	All Ethiopia
SAB632	Speckled	Kidney	400-750	85-90	2015	1500-1800	Middle Rift Valley, South and Harrga
Gobe rash	Motteled	Kidney	350-700	98	1998	1400-1900	Jimma, South Western
Roba-1	Cream	Elong	350-700	75-95	1997	1400-1800	All Ethiopia
GLP-2	Motteled	Kidney	550-100	91	2011	1500-200	Middle Rift Valley
Crans cope	Speckled	Kidney	400-1100	90-98	2007	1300-1950	Middle Rift Valley and south
Gofta	Cream	Elong	500-1200	110	1998	1500-200	Eastern and Western Harereghe
Awash-1	White	Round	350-700	90	1990	1400-1800	Middle Rift Valley

Source: Melkasa Agricultural Research Center

days because the severity (x) was expressed in percent and time (t) in days. The rates of disease progress in time were determine by recording the severity of anthracnose at 7 days interval right from the appearance of the first disease symptoms still the maturity of the crop in the different treatments.

Assessment of crop growth, seed yield and yield components: The Plant height, the number of pods per plant, infected pods per plant and seeds per pod were record from the 10 pre tagged plants. The harvested pods were sun dried and the respective seed yield of the different treatments was measured. Common bean yield data was adjusted at 10% moisture content after measuring with a moisture tester. Seed yield per plot was converted into yield in tons per hectare. The weight of 100 randomly select seeds was also measured.

Statistical analysis

Disease severity was assessed six times on weekly intervals starting from the first visible anthracnose symptoms in the experimental plots. Data on disease parameters such as (disease severity, PSI, AUDPC, disease progression rate and seed yield and yield components (pods per plant, infected pods per plant, seeds per pod, 100 seed weight) were subjected to analysis of variance (ANOVA) using General Linear Model (GLM) procedure of Statistical Analysis System (SAS) version 9.2 software [26]. The mean difference among the treatment were test with Fishers List Significant Difference (LSD) at ($P \leq 0.05$) [27]. relationship among treatment yields, yield components, and disease assessment parameters, such as disease progress rate, percentage severity index, and area under disease progress curve (AUDPC). Logistic, ln ((Y/1-Y), [28] and Gompertz,-ln[-ln(Y)], [29] models were used for estimation of disease progression parameters from each treatment. The goodness of fit of the models was tested based on the magnitude of the coefficient of determination (R^2).

RESULTS

Disease severity on reaction of common bean variety

Differences in response to anthracnose severities and among 22 common bean varieties were clearly observed under field conditions at Sirinka. The analysis of variance for anthracnose severity and AUDPC were highly significant ($P \leq 0.001$) during the whole date of disease assessment period. The severity of anthracnose measured in all 22 varieties had significantly higher values while showed significantly varying resistance to anthracnose (Table 2). During the final disease assessment comparatively, the lower severity level of anthracnose (45.7%, 46.7%, and 46.9%) were recorded from resistance varieties Awash Melka, Gofta and Roba-1 respectively (Table 2). The majority of them (68%) gave a susceptible reaction to the pathogen with more than 50% of disease severity, with heavy symptoms on leaves, stems and pods.

The maximum disease severity levels of anthracnose; 58%, 57.7% and 56.8%, were recorded from susceptible varieties of Awash-1, Biofort and GLP-2, respectively (Table 2). The main reason of less resistant varieties is the possible breakdown of resistance due to the race change of the pathogen to the host resistance [30]. The current finding is consistent with the investigations of Sharma

Table 2: Percentage severity index and area under progress curve (AUDPC) of the response of common bean varieties to anthracnose at Serinka during 2017 main cropping season.

Common bean Variety	Percentage Severity Index (PSI) %						AUDPC
	51DAS	58DAS	65DAS	72DAS	79DAS	86DAS	
Nazareth-2	12bcdf	13.5efgh	18.1g	37.6efg	45.9fghij	48.0hi	1015.7ijk
Awash Melka	10g	11.3h	16.4g	33.1h	43j	45.7i	921.2l
Tabor	13.7ab	16.8abcd	24.1def	45.9abc	49.3bcdef	53.3cdef	1188.0cdefg
KAT B9	13.5abc	16.7abcd	23.7ef	44.7bcd	48.4cdefg	53.2cdef	1167.8defg
Dristu	11.8cdefg	13.3gh	18. 0g	36.2fgh	45ghij	47.8ghi	996.4ijkl
Gofta	10.5fg	11.7h	16.78g	33.6gh	43.7ij	46.7hi	932.0kl
SAB-736	13.2abcd	16.6abcd	23.6f	42.9cd	48.2cdefg	52.3def	1149.1efgh
Ibado	11.1defg	13gh	17.7g	36.1fgh	45ghij	47.5ghi	988.0jkl
Ser-125	12.7abcd	14.5defg	22.0f	38.3ef	47.3efghi	50.3efgh	1074.3hi
Argene	12.4abcdf	14.7defg	21.8f	38.2ef	47efghi	49.3fghi	1068.2hij
Awash-1	14.3a	18.9a	29a	49.2a	53.3a	58a	1305.8a
Nasir	13.7ab	16.97abcd	24.7bcdef	46.9abc	49.4bcdef	53.5bcdef	1201.2bcdef
Crans cope	14.1a	18.1ab	27.1abcd	48.4ab	51.1abcd	56.6abcd	1260.3abc
Gobe rash	14.0a	18ab	26.7abcde	48.3ab	50.7abcde	55.6abcd	1249.0abcd
Awash-2	13.8ab	17.2abcd	24.5cdef	47.3ab	50.2abcde	53.4cdef	1209.4bcdef
Roba-1	10.83efg	11.97gh	17.05g	33.88gh	44hij	46.9ghi	950.3kl
Ser-119	12.9abcd	16.0bcdef	23f	40.7de	47.5defgh	51efg	1114.3gh
GLP-2	14.2a	18.3ab	27.5abc	48.5ab	51.7abc	56.8abc	1270.5abc
SAB-632	13.0abcd	16.3abcde	23.4f	41.2de	47.8defg	52.5def	1130.8fgh
KAT-B1	13.8ab	17.3abc	24.7bcdef	47.7ab	50.2abcde	54.1abcde	1218.1bcde
ICB-0081	13.9ab	17.7ab	24.8bcdef	47.9ab	50.6abcde	55.3abcd	1228.6abcd
Biofort	14.3a	18.4ab	27.6ab	48.7ab	52.3ab	57.7ab	1280.8ab
LSD	1.96	2.81	3.03	4.33	3.77	4.26	85.21
CV (%)	9.19	10.81	8.06	6.18	4.75	4.96	4.56

DAS=Day After Sowing, PSI= Percentage Severity Index, Coefficient of Variation, AUDPC= Area Under Disease Progress Curve, LSD=Least Significant Difference at ($P \leq 0.05$), the mean values in the column with the different letters represent significant variation and the mean values with the same letters are not significantly different.

et al. [31] who found highly significant differences in common bean anthracnose severities were recorded from the resistant and susceptible varieties. Varieties mixtures containing at least 60% of a resistant variety have been reported to offer a good control of anthracnose [19].

Area under disease progress curve

The use of the area under disease progress curve (AUDPC) as a disease severity measure and as a tool for plant resistance evaluation helps to reflect disease progress throughout the whole growing season [25]. Analysis of variance for AUDPC values showed a very highly significant difference ($P \leq 0.001$) between varieties.

There were differences in the AUDPC values among common bean varieties. The differences observed in AUDPC values of varieties indicated differences in resistance level of individual varieties. The lower AUDPC values of bean anthracnose 921.2, 932.0 and 950.3 were recorded from resistance varieties Awash Melka, Gofta and Roba-1, respectively (Table 2). While the higher AUDPC values of 1305.8, 1280.8,1270.5,1260.3,1249.0,1228.6 and 1218.1 were recorded from susceptible variety such as Awash-1, Biofort, GLP-2, Crans cope, Gobe rash ICB-0081 and KAT-B1, respectively, (Table 2). In this study, the highest AUDPC values represented bean varieties with the highest disease infection.

Reaction of common bean variety on yield and yield components

Analysis of variance indicated that, very high significant differences ($P \leq 0.001$) were observed among varieties in plant height. Higher plant height, 100.3, 97.8, 87.7 and 87.3 cm were recorded from Nasir, Tabor, Nazareth-2 and Gofta varieties, respectively, while lower plant height, 30.2,30.8,38.3,42.3and 46.1 were recorded from variety KAT-B1, SAB-736, SAB632, KAT-B9 and Biofort, respectively (Table 3).

Moreover data on yield parameters showed very highly significant differences ($P \leq 0.001$) among varieties in the number of pods per plant, infected per pod, hundred seed weight, seeds per pod and seed yield. The higher numbers of pod per plant; 21.7, 20.8, 20, 18.8 18.7, and 18.0 were recorded from Nasir, Tabor, Nazareth-2, Gofta, Dursitu and Aregne varieties, respectively. However, the lowest number of pod per plant; 7.8, 7.8, 10.3, 10.5 and 10.7 were recorded from KAT-B1, Awash-1, Biofort, ICB-0081, and GLP-2, varieties, respectively (Table 3).

Table 3: Yield and yield component of different common bean varieties in the presence anthracnose pathogen.

Treatment	Yield and yield components					
	PH	NPP(cm)	IPP (%)	SPP	100SW(g)	tha^{-1}
Nazareth-2	87.73ab	20bc	4.7f	5.47d	21.59hi	2.52cd
Awash Melka	55.83defg	13.63e	3.67g	6.33a	23.67ghi	3.03a
Tabor	97.83a	20.8ab	5.8bcd	4.2hi	29.63ef	1.58ghi
KAT B9	42.27ij	12.4efg	5.77bcd	4.37gh	41.14d	1.66gh
Dristu	76.2acb	18.67cd	4.07g	5.6d	25.99fgh	2.64bcd
Gofta	87.3b	18.83cd	3.7g	6.1ab	32.50e	2.93ab
SAB-736	30.87j	11.2fgh	5.73bcd	4.47fgh	40.10d	1.82fg
Ibado	47.7hij	13.07e	4.03g	5.7bc	55.15ab	2.65abcd
Ser-125	44fghi	13.4e	5.33de	4.95e	33.51e	2.36de
Argene	66.27cde	18.03d	4.87ef	5.44d	19.105	2.38de
Awash-1	68.27cd	7.8i	6.733a	3.67kl	22.76hi	1.32hij
Nasir	100.27a	21.73a	5.83bcd	4ij	26.26fgh	1.47ghij
Crans cope	61.2de	11.13gh	6.13abc	3.47lm	48.77c	1.18jk
Gobe rash	55.47efgh	11gh	6.07bc	3.72kl	58.31a	1.27ijk
Awash-2	68.23cde	12.57efg	5.87bcd	3.93ijk	23.99ghi	1.48ghij
Roba-1	67.47cde	18.07d	3.93g	5.93bc	29.49ef	2.81abc
Ser-119	65.27cde	12.73ef	5.67dc	4.73ef	28.46efg	2.28de
GLP-2	58.33def	10.73h	6.13abc	3.43lm	55.45ab	1.41hij
SAB-632	38.27ij	11.33fgh	5.7cd	4.61fg	50.32bc	2.04ef
KAT-B1	30.2j	7.83i	5.93bcd	3.07n	41.047d	0.972k
ICB-0081	65.13cde	10.47h	6.03bc	3.87jk	59.87a	1.32ihj
Biofort (Large5)	46.13fghi	10.33h	6.33ab	3.3mn	51.29bc	1.34hij
Lsd (5%)	12.78	1.598	0.61	0.32	5.44	0.38
CV (%)	12.65	6.98	6.91	4.32	8.88	12.07

PH=Plant Height, NPP= Number Of Pod Per-Plant, SPP=Seed Per-Pod, IPP=Infected Pod Per-Plant, 100SW=Hundred Seed Weigh, Tha^{-1}=Ton Per Hectare, CV =Coefficient of Variation, LSD=Least Significant Difference.
The mean values in the column with different letters are significantly different whereas the mean values with the same letters are not significant different.

Table 4: Correlation coefficient (r) among disease parameters and yield and yield components in different varieties.

Variables	PH	PPP(cm)	IPP (%)	SPP	100SW (g)	tha^{-1}	PSI	AUDPC
PH	1.0							
PP	0.7***	1.0						
IPP	-0.12ns	-0.52***	1.0					
SP	0.18ns	0.55***	-0.89***	1.0				
SW	0.17ns	0.32**	-0.5***	0.6***	1.0			
tha^{-1}	0.14ns	0.5***	-0.84***	0.9***	0.57***	1.0		
PSI	-0.1ns	-0.52***	0.8***	-0.81***	-0.56***	-0.79***	1.0	
AUDPC	-0.12ns	-0.52***	0.9***	-0.91***	-0.56***	-0.86***	0.9***	1.0

PH=Plant Height, PP=Pods Per Plant, IPP=Infected Pods Per Plant, SP= Seeds Per Pod, HSW=Hundred Seed Weight, PSI=Percentage Severity Index, Ns=Not Significant, AUDPC=Area Under Disease Progress Curve, *= Correlation Is Significant At (P< 0.05), **=Correlation Is Highly Significant At (P< 0.01).

Considering infected pods per plant, the reaction of anthracnose showed significant difference among varieties. The lower number of infection of pods per plant; 3.67, 3.70 and 3.9 were recorded from Awash-Melka, Gofta and Roba-1 varieties, respectively while higher numbers of infection pods per plant; 6.7, 6.13, 6.07, 6.13, 6.03 and 6.33 were recorded from Awash-1, Corans cope, Gobe rash, GLP-2, ICB-0081 and Biofort, respectively (Table 2).

Analysis of variance indicated that, there was very highly significant ($P \leq 0.001$) difference among varieties on grain yield of bean. The mean yield varied widely among varieties from 0.972 – 1.47 t ha^{-1} for susceptible varieties and from 2.04 – 3.03 t ha^{-1} for relatively resistant bean varieties. The highest yield (3.03 t ha^{-1}) was recorded from Awash Melka while the lowest yield (0.972 t ha^{-1}) hectare was recorded from Awash-1 variety (Table 3) [31].

It can thus be noted that the measurement of disease may not give a direct relationship to yield, while gives an indication of the amount of yield that may be lost if the plant is susceptible to the pathogen. Nkalubo [32] reported that, differences in yield varied significantly between different accession and not between resistant classifications. There were accessions with an intermediate resistant

reaction that yielded significantly higher than accessions with a resistant reaction. This might be due to the apparent nature of resistant for some common bean genotypes against the disease.

Association of common bean anthracnose and yield parameters

Correlation analysis revealed that, significant negative relationship between anthracnose severity and area under disease progress curve (AUDPC) on plant height, number of pods per plant, number of seeds per pod and grain yield per hectare (Table 4). While highly significant ($P \leq 0.001$) positive correlations were observed between area under disease progress curve (AUDPC), PSI, and percentage pod infection. Disease parameters such as, AUDPC and disease severity (PSI) showed highly significant ($P \leq 0.01$) negative correlations with the seed yield and seed per pod (Table 4). As reported by Sharma et al. [31], highly significant negative correlations between anthracnose severity and percentage reductions in the number of seeds per pod and seed weight [32]. Marcinkowska and Borucka [33] found significant positive correlation between the incidences of C. *lindemuthianum* in *P. vulgaris* seeds and leaf, pod and stem infection by the pathogen under natural field conditions.

CONCLUSION AND RECOMMENDATIONS

The primary goal of this study was to evaluate the reactions of common bean varieties on epidemics of the disease. The anthracnose severity, infected pods per plant and area under disease progress curve (AUDPC) were recorded highest in susceptible varieties Awash-1 followed by Mexican-142 and Awash Melka. The highest anthracnose disease severity was observed in susceptible varieties Awash-1 could be the reason for highest yield loss in the varieties. Anthracnose attacked plant leaves, stems and pods and not only interrupts the plant's ability to take in photosynthetic materials but also utilizes the plant's substrates and damages the host's functions thus reducing its ability to yield effectively.

From twenty two common bean varieties evaluated for the reaction to bean anthracnose under natural infestation conditions, varieties showed significantly ($P \leq 0.001$) different levels of bean anthracnose severity and AUDPC during the disease assessment period. The highest disease severity (58%) was recorded from Awash-1 varieties while the lowest disease severity (45%), was recorded from Awash Melka varieties at final assessment of the day. In the present study confirmed that the efficiency of the reaction of bean verities benefit in terms of the genetic ability resistant varieties to anthracnose.

From the present study, it is possible to conclude that, the advantage of screening resistant verities increases the opportunity to select for a broad range of anthracnose resistance and help to know the variability of the common bean anthracnose disease. Moreover, more extensive screening resistant varieties with different seasons and location studies should be planned for a full assessment of the disease distribution and identifying germplasm materials, as a source of resistance could be important for common bean breeding in Ethiopia.

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