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Research Article

Status of Common Bean (*Phaseolus vulgaris* L.) Diseases in Metekel Zone, North West Ethiopia

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ABSTRACT

Common bean has versatile benefits such as nutritional, environmental and economic benefits for the producers and consumers. However, its production has been affected and threatened by a number of biotic factors. Survey was conducted in 2018/19 cropping season within three woredas of Metekel Zone, Benshangul-Gumz region, Ethiopia, with the objective of identifying and prioritizing haricot bean diseases.The result revealed that haricot bean production in the Zone is affected by eleven diseases which are caused by fungi, bacteria and virus. Based on the disease severity, incidence and prevalence scores, the diseases are categorized in to Major, intermediate and Minor disease. Angular Leaf Spot (*Pseudocercospora griseola*), Anthracnose (*Colletotrichum lindemuthianum*), Floury leaf spot (*Mycovellosiella phaseoli*), and Cercospora leaf spot (*Cercospora cruenta* are grouped in to major diseases. Rust (*Uromyces appendiculatus*), Web blight *Rhizoctonia solani* Kühn (teleomorph *Thanatephorus cucumeris* (Frank) Donk), Ascochyta blight (*Phomaexigua* var. exigua/*Ascochyta phaseolorum* acc) and Bean common mosaic virus (potyvirus) are categorized as Intermediate and the remaining three diseases: Halo blight (*Pseudomonas syringaepv. phaseolicola*), Common Bacterial Blight (*Xanthomonas axonopodis pv phaseoli*) and Downy Mildew (*Phytophthora phaseoli* Thaxt) are grouped under minor diseases. The survey revealed, the common bean production and disease management practices and variety development efforts for the Zone, onwards, should focus on those major disease (such as Angular Leaf Spot, Anthracnose, Floury leaf spot, and Frog Eye leaf spot) in order to sustain production and productivity of common bean cultivars.

Keywords: Common bean; Diseases; Metekel; Pawe; Mandura; Ethiopia

INTRODUCTION

In 2016/17 cropping season, in Ethiopia, common bean covered 290,202 hectares of land, and harvested 4,839,227 quintals of produce with productivity of 16.7 quintals per hectare and it was produced by around 4 million head house hold farmers in Ethiopia [1]. The crop has versatile uses and has versatile benefits such as nutritional, environmental and economic benefits for the producers and consumers.

Although the crop has a huge benefit, its production has been affected and threatened by a number of biotic and abiotic factors. Drought, soil acidity, soil fertility reduction, and climate change are some of the challenges. In addition, Pests (ball worm), diseases which are caused by fungi, bacteria, virus are the biotic factors which limit haricot bean production.

Worldwide rust, anthracnose and angular leaf spot are reported to have wide distributions [2]. In Ethiopia, Common bean suffers from a wide range of leaf, stem and root diseases such as common bacterial blight (CBB), rust, anthracnose, angular leaf spot, web blight and bean common mosaic virus. Among them, Common bacterial blight, rust, and anthracnose are the most important and widely distributed than angular and floury leaf spot [3], while the others though important, are much more restricted in their distribution [4]. Tesfaye, reported that, anthracnose, rust, common bacterial blight, angular leaf spot, ascochyta blight, and bean common mosaic virus are the most important in the country [5]. In the central Rift valley, rust, common bacterial blight and anthracnose are reported to occur simultaneously, at different degrees [3].

Diseases in common bean are known to reduce quality of harvested seed, germinability, and market value of the seed. In addition, depending on incidence, severity disease occurrence, production system and management practice applied, environmental condition, cultivars used and crop stage affected, average yield loss ranged

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between 20% and 100% [6]. Usually, more than two diseases occur together in the same field, thus aggravate the problem. Moreover, pathogens of Angular Leaf spot, Anthracnose, Common Bacterial Blight, Halo Blight, Bacterial Brown Spot, and Bean Common Mosaic Virus are well known to transmit through seeds. Thus, the infected seeds are the primary source of inoculums for the disease. Seedborne fungi are also the principal producers of mycotoxins [7].

Worldwide haricot bean is affected by more than forty-eight (>48) diseases. However, in Ethiopia, few diseases have been reported and documented. The number of diseases would have been increased, if surveys were conducted thoroughly in every production zones of the country. The previous surveys were concentrated in the southern and southwestern parts of the country. So, in this survey, the northern western part of the country was covered was having objective of identifying and prioritizing haricot bean diseases. The result prioritized four diseases to be targeted and develop strategies to control angular leaf spot, Anthracnose and floury leaf spot and *Cercospora* leaf spot in North western Ethiopia.

MATERIALS AND METHODS

Area description

The survey area is located in Metekel zone of the Benshan gulgumz regional state of Ethiopia. It has an estimated area of 51,000 km^{-2} and is located in the north-western part of Ethiopia. Metekel Zone, the study area, is the largest zone in the regional state, with an area of 26,272 km^{-2} followed by Assosa (14,166 sq. km), and Kamashi (8,850 sq. km) [8]. The Zone, occupy >50% in the area coverage, and ~60% in grain crop Production in the Benshangulgumz Administrative region [1]. It has Seven woredas and haricot bean is produced in all woredas. More than 40 types of crops are cultivated in the Zone, the most important ones in terms of area coverage are maize, finger millete, sorghum, groundnut, sesame, common bean, Nug, Tef, pepper and soybean.These crops cover the largest proportion of land in the three surveyed Woredas. The major haricot bean producing woredas are Dibate, Bullen, Dangur and Mandura, followed by Wonbera, Pawe and Guba, respectively. Haricot bean is produced as sole crop, and as rotational crop after finger millet, maize, groundnut and sesame, and as intercrop with maize and sorghum in the cropping system, in the Zone. The survey was conducted by purposively selecting three woredas/districts (such as Dibate, Bullen and Mandura).

Dibate woreda, has an altitude of 1550 m. It received mean annual rain fall of 1072 mm. Its mean annual temperature is in the range 25-29°C (Table 1). Rain begins mostly in April or May ending in October/November. Bush haricot bean varieties are cultivated with major and also the climbing types are also cultivated by the local inhabitants (mostly by Gumuz people). The inhabitants serve in their dish as 'Nifro' and 'shiro'.

Bullen woreda has an altitude of 1450 m. The area received 1643.4 mm mean annual amount of rainfall. It has mean maximum Temperature of 27.9°C and with minimum temperature of 14.7°C (Table 1). Mostly the rain starts in May and almost ends in October. Both climbers and bush beans are grown in the Woreda.

Mandura woreda has an altitude of 1350 m a.s.l. It received high amount of mean annual rainfall of 2030.3 mm. And It has mean maximum daily temperature of 33.4°C and with minimum daily temperature of 18.1°C. The main rainy usually starts in May and Mostly ends in October (Table 1). In Mandura, climbing bean varieties usually are dominant in the 'woreda' and are grown in farmyards usually trained with bamboo [9].

RESEARCH METHODOLOGY

Based on the availability of suitable field for the survey, it was conducted along the main road at 5 to 10 km interval in the right and left of the main road. Three to five sampling points per field were selected in a diagonal or "W" fashion. At each sampling point five randomly selected plants were selected for assessing and estimating the severity of the diseases in percentage, and ten (10) consecutive plants in a row were taken to assess and estimate the incidence of diseases. A total of 15 to 25 plants per field for severity and 30 to 50 plants per field used to estimate incidence, respectively.

Disease severity is defined as the affected leaf area, including the lesion and associated chlorosis (i.e. the non-green area) as a percentage of total leaf area. Most the survey data were collected at around pod filling stages. It estimates how much portion of the total leaf area is infected by the disease and it has more direct effect on yield. Disease incidence is the number of plants infected with the disease as a percentage of total plants, and expressed in percentage. It estimates and shows how many plants are infected over the total plants. Prevalence is the proportion of the disease infected based on the locality (field) and is expressed in percentage. It shows how much the disease is spread over the production area. The severity, incidence, and prevalence in the survey was calculated by the following formula:

$$Severity = \left(\frac{\text{Infected area of the sample plant}}{\text{Total area of a sample plan}}\right) \times 100$$

$$Incidence = \left(\frac{Numberofinfectedplantsinthesamplingunit}{Totalnumberofplantsinthesamplingunit}\right) \times 100$$

$$Prevalence = \left(\frac{Numberoffieldswithdiseaseinfectioninthesurveyedarea}{TotalNumberoffieldsthesurveyed}\right) \times 100$$

Haricot bean varieties used: There are two types of varieties (bushy and running/pole varieties) are produced in the area. More than 40 varieties of common bean are known to be developed in the country. Most farmers in the area utilize three old bushy cultivars such as Nasir (the dominant), Awash-Melka and Awash-1 and few farmers cultivate recently released varieties such as (ser-119, ser-125). In addition to these varieties, runner types of locally cultivated perennial haricot bean varieties are used and produced in the area. They are produced nearby their home and inside the forest area. Since, those varieties require support, the trees used as a support for its production. Climbers (runners) are planted along fences and on the borders of maize fields [9]. The survey was conducted in the farmers' field which grows the bushy type varieties.

RESULTS AND DISCUSSION

The survey revealed that haricot bean production in Meteke Zone is affected by eleven diseases caused by fungi, bacteria and virus (Table 2). Eight of them were fungal diseases (such as Angular Leaf spot, Anthracnose, Frog eye leaf spot, Rust, Web blight,

Table 1: Rainfall, maximum and minimum temperature of 6 years (between 2006 and 2017)* of Bullen, Dibate and Mandura, Woreda.

Climate	Woredas	Months												Total/ Mean
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Rain fall (mm)	Bullen	4.7	3.3	1.5	72.4	153.1	270.9	317.5	381.4	303.2	124.6	9.2	1.5	1643.4
	Dibate	3.4	1.8	15.5	27.2	92.3	163.4	228.1	264.1	197.4	65.9	11.8	1.6	1072.4
	Mandura	0.4	0.7	8.9	46.4	171.1	450.2	539.6	389.2	298.2	95.8	33.7	2.5	2030.4
Max (^{0}C)	Bullen	29.9	31.3	32.4	30.9	27.9	25.4	24.1	24.1	25.2	26.8	28.0	28.8	27.9
	Dibate	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mandura	34.6	37.0	37.4	37.7	36.0	33.2	30.8	28.8	29.5	31.2	32.0	32.7	33.4
Min (^{0}C)	Bullen	11.6	13.7	16.9	17.5	16.5	15.7	15.5	15.1	15.1	14.3	12.6	12.4	14.7
	Dibate	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mandura	20.3	20.7	22.3	21.8	20.6	17.5	15.3	15.2	15.6	15.4	15.9	16.6	18.1

"-" =Data not obtained, "*"=Some data in between are misses.

Table 2: Pest status of haricot-bean diseases (based on incidence, severity and prevalence) in Metekel zone.

S. No.	Disease	Pathogen	Cause	Status
1	Angular Leaf Spot	*Pseudocercospora griseola*	Fungus	Major
2	Anthracnose	*Colletotrichum lindemuthianum*	Fungus	Major
3	Floury leaf spot	*Mycovellosiella phaseoli*	Fungus	Major
4	Cercospora leaf spot	*Cercospora cruenta*	Fungus	Major
5	Rust	*Uromyce appendiculatus*	Fungus	Intermediate
6	Web blight	*Rhizoctoniasolani* Kühn (teleomorph *Thanatephorus cucumeris* (Frank) Donk)	Fungus	Intermediate
7	Ascochyta blight	*Phomaexigua* var. exigua/*Ascochyta phaseolorum* Sacc)	Fungus	Intermediate
8	Bean common mosaic virus	*Potyvirus*	Virus	intermediate
9	Halo blight	*Pseudomonas syringaepv. Phaseolicola*	Bacterium	Minor
10	Common Bacterial Blight	*Xanthomonas axono podispv phaseoli*	Bacterium	Minor
11	Downy Mildew	*Phytophthora phaseoli* Thaxt	Fungus	Minor

Cercospora Leaf Spot, Aschochita Blight and downy mildew); two of them are bacterial (Common bacterial blight, Halo blight); and one of them is viral disease (i.e. Common mosaic virus). Based on the disease severity, incidence and prevalence scores, the diseases can be categorized in to three i.e. Major, intermediate and minor diseases. Angular Leaf Spot, Anthracnose, Floury leaf spot, and Cercospora leaf spot can be grouped as Major. Rust, Web blight, Ascochyta blight and Bean common mosaic virus can be categorized as Intermediate and the remaining three diseases Halo blight, Common Bacterial Blight and Downy Mildew categorized as minor (Table 2). Disease prevalence, incidence and severity varied among the surveyed woredas. The distribution, incidence, severity and prevalence of all observed diseases are indicated in Table 3 below.

Angular Leaf Spot (ALS)

The Angular Leaf spot disease was having an average prevalence of 100%, incidence of 85.5 and severity of 20.6% in the zone. The prevalence of 100% indicates that the disease was existed in every surveyed fields. The highest disease incidence score of 96.3% was obtained in Mandura Woreda, followed by Dibate Woreda with 86.8%. ALS disease severity was highest at Dibate (22.0%) followed by at Mandura Woreda (18.3%) (Table 3). Similarly, Getachew and Habtamu [10] reported the disease with variable severities in different districts (i.e. 61% at Burjdi, of 41% at Konso, 29% at Demba Gofa and 14% at Mihirab Arbaya Districts). Getachew and Habtamu [10], associated the high disease severity with altitude range of below 2000 m.a.s.l., poorly prepared farms, farm saved and local market seed sources, intercropping, early planting, low level of fertilizer application and with high weed.

In the present survey, comparatively low ALS incidence and severity was obtained at Bullen. This can be attributed to the climatic factor, pathogenic variability, host factor and general management of the field. It is the major disease in hot humid areas of the countries. This survey proved that angular leaf spot (ALS) to be the major bean diseases. Rezene et al. [11], reported high pathogenic diversity of ALS with 21 races (Pathotypes) (*Pseudocercospora griseola*) and two of them (63:59 and 19:33) were reported widely distributed. Different authors reported its high probability occurrence of ALS inoculums throughout the season in abundant amount in hot humid areas like Metekel zone [3,12].

A yield loss that reached up to 80% had been reported on susceptible common bean genotypes under severe conditions of infection [6]. Mongi [13], reported yield losses of up to 61% in Southern Tanzania. Stenglein et al. [14], reported that for every 10% increase in ALS severity results in 7.9% yield loss. Fikre et al. [15], reported, for every 1% increase in ALS severity results in 13 to 125 kg/ha yield loss, depending on the cultivar. ALS together with Rust resulted in loss of 54% yield [16]. The major mechanism

Table 3: Disease severity incidence and prevalence of common bean diseases in 'weredas' of Metekel Zone, Ethiopia, in 2018 cropping season.

Diseases	Mandura			Dibate			Bullen			Metekel Zone		
	Sev.	In.	Pre.	Sev.	In.	Pre.	Sev.	In.	Pre.	Sev.	In.	Pre.
ALS	18.3	96.3	100.0	22.0	86.8	100.0	11.7	53.7	100.0	20.6	85.1	100.0
CBB	0.0	0.0	0.0	0.6	3.0	13.3	0.0	0.0	0.0	0.5	2.3	5.3
Ant	6.7	33.3	50.0	17.6	69.4	86.7	14.2	79.6	100.0	15.8	65.4	74.7
FELS	9.5	85.2	100.0	7.8	56.9	73.3	14.2	57.4	100.0	8.6	60.8	89.3
Rust	0.0	0.0	0.0	3.0	23.6	53.3	1.7	11.1	50.0	2.5	19.3	31.3
WB	0.0	0.0	0.0	17.3	66.7	93.3	11.7	77.8	100.0	14.4	58.6	57.3
CMV	0.0	0.0	0.0	8.8	25.7	60.0	5.8	29.6	100.0	7.3	22.6	44.0
FLS	5.8	35.9	100.0	2.4	18.3	46.7	5.0	46.3	100.0	3.1	23.2	78.7
Ascochita	11.5	61.1	100.0	5.4	32.4	66.7	4.2	18.5	100.0	6.1	35.1	86.7
DM	0.0	0.0	0.0	0.3	2.1	6.7	0.0	0.0	0.0	0.2	1.6	2.7
HB	5.0	10.0	33.3	5.0	2.0	5.5	4.0	10.0	33.0	4.8	6.8	22.1

Note: Sev.=Severity; In.=Incidence; Pre.=Prevalence; ALS=Angular Leaf Spot; CBB=Common Bacterial Blight; Ant=Anthracnose; FELS=Frog Eye Leaf Spot; Rust; WB= Web Blight; CMV=Common Mosaic Virus; FLS= Flory Leaf Spot; Ascochita=Aschochita Blight; DM=Dawny Mildew; HB= Halo Blight.

of yield reduction of ALS is leaf defoliation and fastens maturity period, it consequently reduces seed size and yield [15].

The primary source of ALS infection is considered to be infested seed [17] (Cardona- Alvarez and Walker, 1956). It spread within and among fields by wind-blown particles of infested soil, and wind-blown and rain-splashed spores. In addition, crop debris, volunteer crops and off season bean crops are sources of inoculum [16]. Infected seeds and plant debris are the main source of infection for ALS, so the use of resistant varieties, use of clean seed, burial of infected debris and rotation can decrease the severity. In Ethiopia, five resistant common bean genotypes (EMP-233, EMP-212, G-10843 and Dicta-65, and NZBR-2-2) has been identified by Fikre and Abush [18].

Common Bacterial Blight (CBB)

The mean CBB disease occurrence in the surveyed area was insignificant (Table 3 and Figure 1). The average prevalence was 5.3%, the incidence was 2.3% and severity was 0.5%. The disease was obtained only in Dibate Woreda, with insignificant prevalence of 13.3%, incidence of 3% and with severity of 0.6%. The existence of the disease in the other two woredas was not confirmed in this survey. However, the high exchange of seeds among the farmers within the zone and absence of quarantine among the woredas, will make it easy for the disease to be introduced and established in the other woredas. Tesfaye [19], reported, CBB distribution to be high in cooler areas where rainfall is erratic. He obtained, high level of the disease in central rift valley with semi-arid agro ecology, and intermediate level of the disease in Eastern Ethiopia with sub moisture agro ecology and low levels of the disease in semi humid and Moist areas (Jimma, Metu, Hararghe, and Melkassa) [19].

When common bean is exposed to extended period of warm and humid weather, CBB can be highly destructive and causes losses in yield and seed quality, it can result in 22.4% yield loss in Eastern part of Ethiopia [20]. Opio et al. [21], reported, estimated losses due to CBB to be 10-40% on susceptible cultivars in Uganda. The disease has been reported in many parts of Ethiopia.

The pathogens of CBB overwinters in seed, bean debris, and weeds [22]. It can be effectively managed with use of genetic resistance

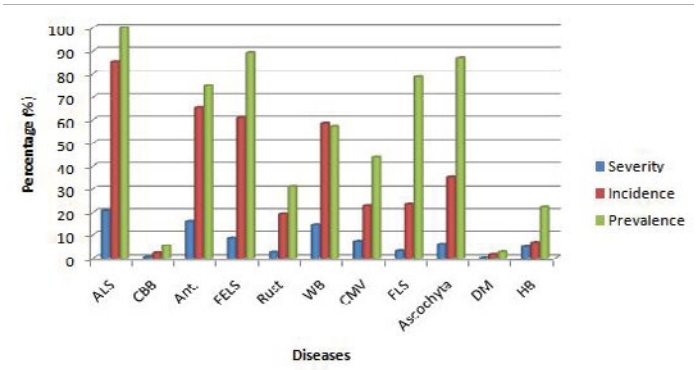

Figure 1: Disease severity incidence and prevalence in Metekel Zone, North West Ethiopia, in 2018 cropping season.

[23] plus use of certified seed, crop rotation, and field sanitation. Kidane [24], reported seed treatment with streptomycin enhanced yield by 15.6% over untreated control; and foliar application of Kocide-101 significantly increased yield of common bean varieties by approximately 18.5% at Melkassa and Arsi Negelle over unsprayed control. He also revealed, yield gain between 27.0% and 38.0% at Melkassa and between 27.6% and 36.1% at Arsi Negelle by integrated application of seed treatment of streptomycin with twice and once foliar sprays of Kocide 101.

Anthracnose (Ant)

Anthracnose is one of the most important diseases of common bean in Ethiopia. It occurred with prevalence of 74.7%, incidence of 65.4 and severity of 15.8, in the surveyed woredas. The survey revealed the variability of the disease from 50 to 100% in prevalence. The disease (Anthracnose) heavily attached the crop in Bullen wereda with 100% prevalence, with 79.6% incidence and with 15.8%severity scores, followed by Dibate, with 86.7% prevalence, 69.4% incidence and 17.6%severity scores. So, anthracnose is an important disease in the three woredas. Habtu et al. [3], reported Anthrachnose to be widely distributed and economically the most important in Ethiopian and high plant density and high weediness has associated with high anthracnose in the Rift Valley.

Similarly, Tesfaye [19], obtained anthracnose in all surveyed areas, with high incidence at Bako, Didessa, Ambo, Arsi-Negele, Meki

and Areka. He also reported high severity of bean anthrachnose in the humid zone (H2) and high incidence to be associated to semi-arid (SA) zones. In agreement with this report, the surveyed area receives annual rain fall between 1072 and 2030 mm and mean minimum and Maximum rainfall of 16.4°C and 37°C. This result is consistent with previous reports that anthracnose is more severe in regions with high rainfall and moderate temperature.

Wide Variability i.e., 14 races of the pathogen has been reported and two of them were reported to have wide distribution. These reported races are 63, 65, 68, 73, 81, 128, 296, 465, 511, 589, 961 and 1027 [19]. Races 128 & 511 were reported common and were having wide distribution. Roba-1 variety was found to be resistant registered variety in Ethiopia [25]. In Ethiopia, anthracnose has shown to reduce yield up to 70% [26].

Cercospora leaf spot

Cercospora leaf spot is also one of the most important disease of haricot bean in Metekel zone. Its distribution expressed in prevalence was 89.3% in the zone but it was 100% at Mandura and Bullen woredas, and 73.3% in Dibate (Table 3 and Figure 1). The disease severity and incidence score was 8.5 and 60.8, in the zone. The high disease incidence was scored at Mandura (85.2%) and Bullen (57.4%) Woreda. The mean severity score ranged between 9.5 (at Mandura) and 14.2 (at Bullen) (Table 3).The reason for high incidence, severity, and prevalence in the zone and in Mandura in particular might be connected toits management practices in the area.

Cercospora leaf spot, caused by *Cercospora cruenta* and *C. canescens*, causes severe leaf spotting and defoliation during the time of flowering and pod formation. It can use different hosts such as cowpea, green grams and soybean [27]. The pathogen can survive in infected seeds and in surface debris in the field for extended periods [28]. Involvement of different species in causing cercospora leaf spot complicates characterization of species. Yield losses of 50% in severely diseased field have been reported [27]. Pande et al. [29], reported use of disease fee seeds, field sanitation, crop rotation, destruction of infected crop debris, and avoiding alternate hosts near the crop may help in reducing the incidence.

Rust

Common bean rust, is caused by *Uromyces appendiculatus* (Pers.) Unger, was obtained in Dibate and Bullen woreda but not in Mandura Wereda. It was occured with less than 50% prevalence, 19.3% incidence and 2.5% severity in the zone. Relatively, rust is more important at Dibate than the other woredas. Habtu [30], reported, rust to be the production constraint in Ethiopia. Tesfaye [19], reported low level of rust in humid and sub-humid (Bako) agro ecologies and intermediate level of rust in sub-humid and moist agro-ecologies (Jimma, Metu, Hararghe, and Melkassa). Similarly, Habtu et al. [3], reported variability of rust occurrence to based on location, weed management and plant density. They revealed high disease intensity at Sidama Zone, to be associated with low plant density and low weediness.

Long distance dissemination of rust inoculum is mainly by wind [31]. However, short distance dissemination may occur through contaminated farm implements, clothing and insects [16]. Habtu et al. [32], reported yield losses varied based on level of resistance of varieties, intensity of the rust, location and season. They demonstrated, yield loss ranged between 43 and 85% at Ambo and Debrezeit on susceptible and 30% in partially resistant variety. Pastor-Corrales and Liebenberg reported high severities of rust occurs in cool (17–22°C) and humid (>95% humidity) environment). Wortmann et al. [33] reported an estimated yield loss of 191,400 metric tonnes per annum in Africa.

Mersha and Hau [34] reported the disease to be favored by cool to moderate temperatures, high moisture, infected plant debris and volunteer plants, cultural practices, late planting, herbicide damage, excess nitrogen or hail damage. Repeated disease cycles may occur at 10 to 14-day intervals under favourable conditions. The disease can be managed by the use of crop rotation, deep ploughing of infected debris, early planting and use of resistant varieties [35]. Resistant varieties are widely used to control ALS and rust diseases of common beans [14]. However, their use is often limited because of high pathogen variability in the field.

Web blight

Web blight has high prevalence at Bullen (100%) and Dibate (93.3%), with the incidence of 77.8 and 66.7, and severity score11.7, and 17.3 respectively. It is one of the potential diseases in Metekel zone. It was previously reported by Mohammed et al. [36], at the same location. The disease favoured by hot humid weather and moderate temperature.

Web blight (WB) of common bean (*Phaseolus vulgaris* L.) is caused by aerially dispersed isolates of *Rhizoctonia solani* Kühn (teleomorph *Thanatephorus cucumeris* (Frank) Donk) resulting in defoliation and pod infection which leads to mild to severe yield and seed quality losses. The pathogen spreads by airborne basidiospores, mycelial bridges between plants, rain-splashed sclerotia, infested soil debris, and infected seeds. It is reported to be problematic in East Africa [37].

The WB pathogen, *R. solani* (Rs), is a complex species composed of subgroups within Anastomosis Groups. At least six subgroups of Rs cause symptoms of web blight [38]. Variability among these sub-groups includes different virulence patterns, fungicide resistance, optimal growth temperature and epidemiology (disease development rate, fungal propagule type, dissemination and survival).

Bean common mosaic virus

BCMV is caused by *potyvirus* has high prevalence of 100% at Bullen, with 77.8% incidence and 11.7% severity (Table 3 and Figure 1). In addition, the 60% prevalence, 25.7% incidence and 8.8% severity makes it an intermediately important disease.

BCMV has worldwide occurrence and reported to cause 50-70% yield loss [39]. It is a non-persistent, aphid-transmitted potyvirus and distributed nearly in every country where beans are grown. Primary source of infection occurs through infected seed that ensures the wide dispersal of the virus became seed production programs in many countries. Drijfhout [40] reported BCM was first reported in 1899 by Iwanoski in Russia. The presence of aphid vectors and susceptible cultivars aggravates the problem by the disease [39].

Use of disease resistance cultivars, use of pathogen-free seed which certified by appropriate seed agencies, production of seeds in

pathogen unfavorable environment [39], and vector management are importance BCMV disease management strategy.

Downy mildew

Dawny mildew is reported to be caused by *Phytophthor aphaseoli* Thaxt, is one of the minor diseases in Metekel zone. It was obtained with prevalence of 2.7%, severity of 0.2% and incidence of 1.6% and only obtained in Dibate woreda, with prevalence of 6.7%, severity of 0.3 and incidence of 2.1%. It is the first report in Ethiopia.

Evening dews and leaf wetness provide ideal conditions for the development of downy mildew and reported to have six races [41]. *P. phaseoli* has been reported to overwinter as oospores on infected lima bean and are the primary inoculum, with the secondary inoculum being sporangia [42]. Oospores may produce germ tubes and infect the plant directly or may produce sporangia. A report of the disease on common bean is scarce and further survey and confirmation is needed.

Floury leaf spot

Floury Leaf Spot is one of the most important diseases of haricot bean in Ethiopia. It occurred with high prevalence of 78.7%, incidence of 23.3 and severity of 3.1, in the surveyed Zone. The prevalence of 100% at Bullen and Mandura Woreda whereas with 46% in Dibate. The disease incidence of 46% was higher at Bullen followed by 35.9 and 19.3 at Mandura and Dibate respectively. The disease severity scores were higher at Mandura and Bullen with 5.8 and 5.0% respectively. So, Floury Leaf Spot is one of the most important diseases in the three woredas. Similar to this report Tesfaye [19], reported floury leaf spot to be highly prevalent in the warm and humid regions of the country.

Aschochyta leaf blight

It is one of the most important diseases in Metekel zone. It occurred with prevalence of 86.7, severity of 35.5 and incidence of 6.1%in the zone. Prevalence of 100% was recorded at Mandura and Bullen woreda. The incidence and severity of attack at Mandura was 61.1% and 11.5%, respectively, was higher than that of Bullen and Dibatse. The least disease severity (of 32.4%) and incidence (of 5.8%) score was obtained at Dibatse.

It is one of haricot bean fungal diseases caused by the fungus *Phoma exigua* var. exigua =*Ascochyta phaseolorum*. Trapero-Casas and Kaiser [43], reported disease progression occur from 5°C to 25°C with an optimum temperature of 16-20°C, and a minimum of 6 hours of leaf wetness. Disease severity increases with the increase in relative humidity. Tivoli and Banniza [44], reported cloudiness and prolonged wet weather favour rapid development and spread of the disease. The symptoms involve large dark grey to black spots that later become zonate with concentric rings around the spot. Stems when infected the nodes are blackened and premature leaf drop may occur. Pod infection can result into formation of cankers and results in seed infection. The pathogen survives on infected or contaminated seeds and infected plant debris [45]. Integration of cultural methods, fungicides and use of resistant genotypes are the effective methods of control the disease [27].

Halo blight

Halo blight, caused by *Pseudomonas syringae* pv *Phaseolica*, is one of the least important diseases in Metekel zone. It was obtained with prevalence of 22.1%, severity of 6.8% and incidence of 4.8%. The extent of attack at Mandura and Bullen woredas were higher than that of Dibatse Woreda. High humidity and cool temperatures favours disease development [46].

Habtu [4], reported four races (races 1, 2, 3, and 4) of *Pseudomonas syringae* pv. *phaseolicola* from Ethiopian collections. Taylor et al. [47], reported nine races (1 to 9) and five (2, 4, 6 & 7) of them were Ethiopian isolates. Worldwide, a number of races (1, 2, 5, 6 and 7) were distributed with race 6 being pre-dominant.

The disease can cause discoloration, shriveling and contamination of seeds. So, seeds are the major source of infection. Serious losses due to HB have been documented in Lesotho, Rwanda and Zimbabwe while yield losses of 43% have been reported in experimental conditions [46]. Deep ploughing, crop rotation, use of clean seeds, use of resistant varieties and use of fungicides are recommended for the disease.

CONCLUSION

The survey revealed that haricot bean production in Meteke Zone is affected by eleven diseases caused by fungi, bacteria and virus. Majorities (Eight) of them are fungal diseases, two of them are bacterial and one is viral disease. Based on the disease severity, incidence and prevalence scores, the diseases are categorized in to Major, intermediate and Minor disease. Angular Leaf Spot, Anthracnose, Floury leaf spot, and Frog Eye leaf spot are grouped as Major. Rust, Web blight, Ascochyta blight and Bean common mosaic virus are categorized as Intermediate and the remaining three diseases: Halo blight, Common Bacterial Blight and Downy Mildew are grouped under minor diseases. So, in common bean production, the disease management practices and variety development efforts in the Zone, onwards, should focus on those major diseases (Angular Leaf Spot, Anthracnose, Floury leaf spot, and Frog Eye leaf spot) in order to sustain production and productivity of common bean cultivars.

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