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PEPPER DISEASE ASSESSMENT AND IDENTIFICATION IN MAJOR GROWING DISTRICTS OF WEST GOJAM ZONE IN NORTHWESTERN ETHIOPIA

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ABSTRACT

Hot pepper (Capsicum annuum) is an economically and traditionally an important crop in Ethiopia. It is also necessary vegetable crop mainly for small-scale farmers in Amhara National Regional State of Ethiopia. The productivity of this crop is low under national level, it is said to be 7.36qt per hectare. It is even lower to that of the national in Amhara National Regional State growing areas. Assessing pepper growing areas and collect damaged plants by the disease and identification of diseases was the focus of this study. Three districts were selected purposively based on accessibility, production and problem, available time, logistics, and representativeness. In each district three representative peasant administrations (PAs)/kebeles were selected. Sampled kebeles and respondents were selected using simple random sampling techniques. A total of 135 respondents were selected for interview. The data was collected through semi structured interview schedule. In each PA, three simple random sample selected farmers' fields were assessed. The assessment was done at one growth stage of the plant (flowering-podding stage). The collected data was analyzed using descriptive statistics. The findings of this study confirm that in all the surveyed peasant farms, only one type of variety, which is Marekofana was encountered with low to high levels infestation of different leaf, stem, and root diseases. Root rot/wilt complex diseases were found distributed in almost all the surveyed areas. The prevalence of the disease, pepper wilt/root rot complex is high, therefore; efforts better to be made towards the integration of multiple control options.

Contribution/Originality: This study contributes in the existing literature to fill the gap of the current state of knowledge of pepper disease assessment and identification. This study is one of very few studies which have investigated pepper disease assessment and identification. The paper contributes the first logical analysis of pepper disease.

1. INTRODUCTION

Vegetables are an integral part of the farming system, which plays a vital role in the economy of Ethiopia (Emana *et al.*, 2015). They are the most important food and income generating crops in many parts of Ethiopia, widely cultivated both by small-scale farmers, and state enterprises (Mohammed, 2005). Mounting and diversifying vegetable production can help to overcome malnutrition and poverty by enhancing household consumption and become market opportunities for smallholders. Moreover, vegetable value chains can offer new income and employment opportunities in trading and processing sectors (Ganry *et al.*, 2011; Virchow, 2014). Nationally

vegetables took up 1.08% of the area under all crops, from this 69.31% was under hot pepper (CSA (Central Statistical Authority of Ethiopia), 2006).

Hot pepper (Capsicum frutescens) is the most important vegetable, which can be found on the daily dish of every Ethiopians (Mohammed, 2005). According to Beyene and David (2007) in Ethiopia hot pepper (*Capsicum annuum*) is an economically and traditionally vital crop, and for most Ethiopians food is tasteless without hot pepper. The fine powdered pungent product is an important flavoring and coloring component in the common traditional sauce "Wot", (stew). In addition to dietary benefits, *capsicums* are also high value crops in both domestic and export markets. Since it is an industrial Crop, it generates employment to urban and rural workers. The deep red colored cultivars have a very high processing demand in the country (EEPA (Ethiopian Export Promotion Agency), 2014).

Central Statistical Agency Agricultural Sample Survey (CSAASS (Central Statistical Agency Agricultural Sample Survey), 2012) stated that, in Ethiopia hot pepper covers 69.31% of all the area under vegetation covers. It is also an important vegetable crop mainly for small-scale farmers in Amhara National Regional State of Ethiopia (EEPA, 2003). It is grown both under rain fed and irrigated conditions.

According to MARC (Melkasa Agricultural Research Center) (2004) the daily consumption of hot pepper by Ethiopian adult is on average estimated 15g, which is higher than tomatoes and most other vegetables. It is also an important vegetable used in the daily dishes of Amhara Region which is consumed both as fresh and dried powder forms. However, this crop is severely attacked by many diseases, and a significant yield loss has been recorded every year (Mohammed, 2005). In spite of its importance, hot pepper production system for green and red pod has stayed low with a national average yield of 64.20 qt/ha for green pod, whereas it was 21.96 qt/ ha for the dry pod, respectively (CSA, 2006). It is even lower to that of the national in Amhara National Regional State growing areas (MoARD (Ministry of Agriculture and Rural Development), 2009). This might be attributed to the use of low yielding varieties, drought, insect pest, diseases, and poor cultural practices (Fekadu and Dandena, 2006). According to Faisal and Muhammad (2011) the cause for significant losses in this crop production and productivity was due to a number of factors including poor quality seed, mal-cultural practices and diseases like viruses, collar rot and *Phytophthora* root rot.

According to Faisal and Muhammad (2011) the yield of hot pepper is reducing gradually every year due to different pests and pathogens which cause heavy losses. These disease infections and pest infestations severely reduce the production and profitability of this crop even further by reducing the period in which the crop was harvested. For example, up 100% loss from pepper anthracnose (Melanie and Sally, 2004) while bacterial spot caused by a seed borne bacterial pathogen (*Xanthomonas campestris* pv. *vesicatoria*) is also capable of causing severe defoliation of plants, resulting in reduced yield (Sun *et al.*, 2002). According to Fekadu and Dandena (2006) up to 30% of vegetable harvests in Ethiopia is reported to be lost due to poor post-harvest handling. Similarly, Haileslassie *et al.* (2015) emphasized that lack of research on adaptability and improper or inadequate crop management practices can result in poor crop yields and high production costs

In Amhara Region of Ethiopia particularly West Amhara, pepper is majorly grown in districts such as Jabitahinan, Burie-Wonberma, Guagusa-Shikudad, North and South Achefer of West Gojam zone and Guangua of Awi zone and Dera-Hamusit and Fogera of South Gondar zone and Delgi and Dembia of North Gondar zone respectively (BoA (Bureau of Agriculture), 2014). Even though the growing areas have a great potential in terms of physical environment and market opportunities, the production and productivity of pepper is becoming decreasing (BoA, 2014). According to Tameru *et al.* (2003) in the region total crop failure due to diseases has been common and farmers are sometimes forced to abandon their production due to excessive infection pressure in the field. Despite this fact, the identity and relative importance of the disease in the region has not been well documented. So it was very important to assess and identifying the causal pathogen. Beside to this, socio economic data on the knowledge of the pepper production were not collected at household level. Therefore, this study was set off to assess the

distribution and incidence of pepper diseases, to collect and identify the diseases of pepper and to collect data on the knowledge of pepper production at household level to reduce crop losses; and to document information which can be used in developing integrated management strategy against hot pepper diseases.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

Field survey for pepper diseases was done at three districts (*woredas)* in West Gojam administrative zone of the Amhara National Regional State (A.N.R.S), Ethiopia, during the main crop season. The studied districts were, Jabitahinan, Burie, and South Achefer.

The altitude of the study districts ranges from 1700-1900 m. a.s.l, which is dominated by red soils. There is one effective rainy season that extends from June to September. A long dry season follows with intermittent showers, especially in April to May, that are not sufficient to grow crops but are used in land preparation. The temperature also ranges from 14-37° C. in these districts.

2.2. Sampling Procedure and Sample Size

In order to build up a sample that is satisfactory to their specific needs. Researchers handpick the cases to be included in the sample on the basis of their judgment of their typicality or possession of the particular characteristics being sought; purposive sampling is important, Cohen *et al.* (2008). Therefore, three districts were purposively selected based on accessibility, available time, logistics, and representativeness. In each district three representative peasant administration (PAs) or kebeles were selected based on simple random sampling method. From these 9 PAs, 135 farmers were selected using simple random sampling technique. Assessment of pepper disease was made in nine PA's (Bakel, Shembekuma, Mankusa, Allefa-Bassi, Debune fuat,Adelagate,Ahuri, Kere, and Abchikli) where farmers transplant from seed bed. A total of 27 pepper field crops (3 per PA's) were assessed and 205 samples were collected.

2.3. Data Type and Data Source

Primary and secondary data sources were used to collect both qualitative and quantitative data. The primary data sources were from pepper growing farmers (respondents). The secondary data sources were from strategic plan of agricultural and rural development office, prepared annual plan, and report, training reports, prepared project documents of the district Office of Agricultural and Rural Development.

2.4. Methods of Data Collection

Data was collected using a pre-tested semi-structured interview schedule. The interview captured socio-economic and demographic variables, planting methods, planting time, seed source, its management by farmers at household level, extension information, market, credit, fertilizer application, and knowledge on pepper disease. Quantitative data was collected through personal interviews. The methods used to collect qualitative data include those often associated with participatory methodologies such as focus group discussions, field visits, observations, informal interviews with key informants, and discussion with Agricultural and Rural Development office workers.

Pepper assessment was carried out from July to September. In each field, diseases were assessed and sample of disease specimens were collected. Disease incidence and severity was scored for each disease symptom and diseased samples were collected by visual observation. The observation, the assessment, and collection were carried out together with the farmers.

Farms were visited diagonally (using an "X"fashion), and the disease incidence was estimated by using 3 m x 3 m quadrant. The number of diseased plants and the total number in each quadrant were recorded. Disease incidence was calculated as the percentage of infected plants in each field at each location. The assessment was done at one

growth stage of the plant (flowering-podding stage). The numbers of diseased crops per PA's were documented. Finally percentages of infected crops in relation to total inspected fields were computed to determine disease prevalence.

During the survey period naturally infected plants of different parts (root, stem, leaf, and pod) which showed suspected typical symptoms of different diseases were collected. A total of 205 samples were collected and brought to Ambo Plant Protection Research Institute/EIAR at Ambo Plant Protection laboratory for isolation and identification of the pathogen.

2.5. Data Analysis

Following the completion of the data collection, diseases identified and causal organisms were recorded in collaboration with Ambo Plant Protection Research Institute; the socio-economic data were coded and entered into Statistical Package for Social Science (SPSS version 20) computer program for analysis. Primary data collected from individual and group respondents, as well as the identified disease and causal organisms were analyzed using descriptive statistics such as mean, standard deviation, frequency, percentages, and cross tabulation (Gomez and Gomez, 1984). Mean comparison methods (chi-square test) were deployed to compare and test the level of disease, awareness about pepper disease, and availability of extension information.

3. RESULTS

3.1. Surveyed Areas and Localities

The field survey covered one administrative zone, three districts, nine peasant administrations (PA's), and 27 pepper farmer fields Table, 1. The altitude of the surveyed area ranged from 1700 to 1950m above sea level. In all the surveyed peasant farms, only one type of variety that is *Marekofana* was encountered (Table, 4) with low to high levels infestation of different leaf, stem, and root diseases Table 7, 8, 9, and 10. In some pocket areas, farmers are also growing local pepper cultivar in which it is extremely diseased by root rot and wilt complex. Unfortunately during field survey we did not get local cultivar except *Marekofana.*

Table-1. Surveyed areas including localities and altitudes for Pepper diseases

Administrative Zone	Districts	Localities (PAs)	Altitude range in m
West Gojam	Jabitahinan	Bakel	1700 - 1800
		Shembekuma	1750 - 1850
		Mankusa	1700 - 1800
	Burie	Allefa-Bassi	1900 - 1950
		Debune fuat	1750 - 1850
		Adelagate	1900 - 1950
	South Achefer	Ahuri	1750 - 1950
		Kere	1800 - 1950
		Abchikli	1700 - 1800

Source: Districts, Agricultural office.

3.2. Demographic Characteristics of Sample Farmers

The category of respondents during survey was indicated as follow. It showed that the sex, educational level, and age category for respective districts Table, 2.

The Table shows that about 10.3% and 2.2% of the sample household heads were illiterate and has religious school background, respectively. About 43.7% can read and write whereas 22.9 % had joined secondary school. These differences were statistically different ($P< 0.05$).

Table 2 further depicts that the average age of the sample household heads were 38. Respondents below 35 and above 65 years of age were 8.9%, where most of the respondents were in the active age group. It showed that pepper production in the study areas were mainly conducted by the active age group of the society.

Table-2. Distribution of household head by sex, educational status and age category

variables		District								χ^2-value
		Burie (55)		Jabitahinan (47)		South Achefer (33)		Total		
		№	%	№	%	№	%	№	%	
Sex	Female	15	46.9	11	34.4	6	18.8	32	23.7	
	Male	40	3□.8	36	35	27	26.2	103	76.3	0.9
Educational level	Illiterate	6	42.9			8	57.1	14	10.3	
	Read & write	27	45.8	18	30.5	14	23.7	59	43.7	
	Elementary	9	32.1	8	28.6	11	39.3	28	20.7	
	High school	10	32.3	21	67.7			31	23	37
	Religious	3	100					3	2.3	
Age category	<35	3	25	8	66.7	1	8.3	12	8.9	
	35-45	17	34	18	36	15	30	50	37	
	46-55	15	40.5	15	40.5	7	18.9	37	27.4	18
	56-65	10	41.7	6	25	8	33.3	24	17.8	
	>65	10	83.3			2	16.7	12	8.9	
	Mean	38								
	S.D	11.7								
	Maximum	67								
	Minimum	20								

Remark: - *P* values 37 & 18 were significant at less than 1% & 0.9 was significant at less than 10%

Land Allocation of Pepper. The land cultivated for pepper production in the year 2012/13 was about 43.33 hectares in all sampled households and equivalent in both areas Table, 3. An average land holding for all respondents is 0 .36 ha. From the three pepper grower sampled districts, Bure allocated more land than the others. According to the discussant the cultivable land for pepper is reducing because of minimum production.

Table-3. Distributions of land allocation in 2012/2013 for pepper production year, experience and purpose of pepper production

variables	Level	District								χ^2-value
		Burie(55)		Jabitahinan (47)		South Achefer (33)		Total		
		№	%	№	%	№	%	№	%	
Land allocated for pepper production	0.01-0.05			1	50	1	50	2	1.5	
	0.06-0.1	8	38	7	33.4	6	28.6	21	15.5	
	0.21-0.25	15	21.7	31	44.9	23	33.3	69	51.2	3.1
	0.26-0.5	20	57.1	5	14.3	10	28.6	35	25.9	
	0.6-1			8	100			8	5.9	
	Mean	.36								
	SD	.21								
Experience in pepper production	<5		100	1	100			1	0.8	
	6-15	25	35.2	25	35.2	21	29.6	71	52.5	
	16-25	21	75	2	7.1	5	17.9	28	20.7	33.7
	26-30	8	33.3	12	50	4	16.7	24	17.8	
	>30	1	9.1	7	63.6	3	27.3	11	8.2	
Purpose of pepper production	marketing	15	32.6	31	67.3			46	34	
	consumption					3	65.2	3	2.3	
	marketing and consumption	40	46.5	16	18.6	30	34.8	86	63.7	

Remark: - *P* values 33.7 was significant at less than 5% and 3.1 was significant at less than 10%

Table, 3 shows that the average years of farming experience for total sampled household was 24 years. From the three sampled districts Jabitinan farmers had more experience in pepper production. The Table further reveals that 34% sampled farmers used pepper for marketing as primary purpose where as 63.7% farmers' used for marketing and household consumption. It indicated that farmers produce pepper for marketing purpose to increase income.

The entire sample household got *Marekofana* seed variety from market (merchant) 14%, agricultural office 42.3%, cooperatives 21.5%, and other sampled farmers 22.3% got from agricultural office and merchant Table, 4.

Table, 4 further reveals that 96.2 % of the sampled farmers practiced transplanting and 3.8 % direct sowing method, the chi-square test indicated that there is a significant difference among respondents of pepper producers at 1% significance level.

Table-4. Name and Sources of Improved Seed and method of planting (Transplanting)

Variables	Level	District								χ^2-value
		Burie (55)		Jabitahinan (47)		South Achefer (33)		Total		
		№	%	№	%	№	%	№	%	
Name of improved variety	Markofana	55	40.7	47	34.8	33	24.5	135	100	
Source of improved seed	Agricultural Bureau	27	47.3	19	33.4	11	19.2	57	42.3	
	Merchant	14	3.6	0		5	26.3	19	14	
	Cooperatives	14	48.2	2	6.8	13	44.8	29	21.5	
	Agricultural Bureau and Merchant	0		26	86.6	4	13.4	30	22.2	
Planting method(transplanting)	yes	55	40.7	47	34.8	28	24.5	130	96.2	
	no	-	-	-	-	5	100	5	3.8	10.3
Usage of pepper	green	5	27.8	3	16.7	10	55.6	18	13.4	
	pepper	50	42.7	44	37.6	23	19.6	117	86.6	

Remark:- *P* values 10.3 was significant at less than 10%

Paper is generally harvested when ripe, but it can also be harvested at a green, immature stage. Maturity of green paper can be based on size, firmness, and color. It showed that 86.6 % of the sampled farmers used ripe red peppers and 13.4 % used green for market and household consumption Table, 4.

Different methods of pepper production were practiced in the study areas, 73.3% of the sampled farmers produced using rain, from these respondents 32.5% were from Jabitahinan district. Irrigation method of production used by 2.9% of the sampled farmers from Jabitahinan and South Achefer districts while 22.9 % used rainy and irrigation which included Bure and South Achefer districts Table, 5.

Table-5. Storage and production system of pepper

Variables	Level	District								χ^2-value
		Burie (55)		Jabitanane (47)		South Achefer(33)		Total		
		№	%	№	%	№	%	№	%	
roduction season	Rainy	32	32.3	45	45.5	22	22.2	99	73.4	36
	Irrigation			1	25	3	75	4	2.9	
	Rainy and irrigation	23	71.9	1	3.1	8	25	32	23.7	
Tradition of storage	yes	37	35.2	40	38.1	28	26.7	105	77.8	9
	no	18	60	7	23.3	5	16.7	30	22.2	
Method of storage	Filling in sack & placing in *'kot'*	26	17.1	40	36.1	27	35.2	93	88.6	22
	Gottera'	11	9.5	-	-	1	1.9	12	11.4	
Motive of storage	Expecting high price	32	33	40	41.2	25	25.8	97	92.3	19
	Saving	5	62.5	-		3	37.5	8	7.7	
Achievement of the motive	yes	37	50	14	18.9	23	31.1	74	70.5	41
	no	-	-	26	83.9	5	16.1	31	29.5	

Remark:-*P* values 22 was significant at less than 1% & 41, 36,19,& 9 were significant at less than 10%

The current showed that 77.8% of the sampled farmers have tradition to store pepper and 22.2% did not store their produce because of small production and productivity. Selecting storage system is a major farming activity in order to avoid post-harvest losses. About 88.5% of the total sampled farmers indicated that they put their pepper by filling in sack and placing it at '*kot*' (shelf) where as 11.4% of the sampled households showed that they put in *gottea* (mud made storage). The data showed that the storage system in the study areas were not identical.

From Table, 5 one can see that 17.1% of the sampled households in Bure, 36.1% Jabitinan, and 35.2% of south Achefer store their pepper by filling it in sack and placing it at *kot*'. The Table makes clear also 9.5% of the household from Bure and 1.9% of households from south Achefer placed their pepper in store or '*gotera*'. The others stored their pepper on the floor and in a large basket called *'kefo'*. Chi-square test indicated that there is a significant difference on storage system between the three areas at less than 1% level of significance.

The current showed that, 105 sampled farmers avoided sales immediately after harvest in both areas, but 83.8% stored for about 12 months. Table, 5 further illustrates that about 92.3% of total sampled farmers responded that, the major reason for storing was high price expectation and 70.4% secured the expected price. However, about 7.7% of sample households, who stored pepper, for saving purpose. The chi-square test revealed that there was a significant difference in the underlying reason for storing pepper at less than 1% level of significance Table 5.

Access to service like credit and agricultural extension service are the most important factors that promote production and productivity thereby increasing marketable surplus and farm income. From Table 6 one can see that 91.8% of the total sampled household had extension contact in relation to pepper production.

Table-6. Extension service in relation to pepper production in the 2012/13 cropping season

Variables	Level	District								χ^2-value
		Bure (55)		Jabita□inan (47)		South Achefer(33)		Total		
		№	%	№	%	№	%	№	%	
Extension contact	Yes	48	38.7	46	37.1	30	24.2	124	91.8	3
	No	7	63.6	1	9.1	3	27.3	11	8.2	
Frequency of extension agent contacted	Weekly	32	35.2	38	41.8	21	23.1	91	73.4	30
	Once in two week	2	25	-	□	6	75	8	6.5	
	Monthly	4	26.7	8	53.3	3	20	15	12.1	
	Any time when I ask them	10	100	-	-	-	-	10	8	
Credit need in 2012/13?	Yes	41	41.4	39	39.4	19	19.2	99	73.4	6
	No	14	38.9	8	22.2	14	38.9	36	26.6	
Availability of credit in 2012/13?	Yes	36	48	31	41.3	8	10.7	75	75.7	15
	No	5	20.8	8	33.3	11	45.8	24	24.3	

Remark: - *P* values 15 was significant at less than 1% & 6, 30, ,& 3 were significant at less than 10%

The table makes clear also that more of Jabitahinan farmers (37.1%) had extension contact than others. From the table different sampled farmers contact the extension agent in different times, 73.4% of the sampled farmers contacted the extension agent weakly, 6.5% once in two weeks, 12.1% monthly, and 8% at any time of the farmers' interest. According to the chi-square test there was a statistically different on extension services between the two areas at 1% level of significance.

However, from the total 135 sampled respondents about 73.4% pointed out that they need credit and 75.7% of them had received credit. More of the Bure farmers 41.4% needed credit than other district farmers and 48% received credit. The chi-square result shows that there is statistically significant difference at less than 5% level on credit need.

3.3. Distribution, Incidence and Severity of Pepper Diseases in Surveyed Areas of West Gojam Zone

During the assessment of farmer field, one variety was found dominant and both leaf diseases and root diseases were observed, but in all assessed fields root rot/wilt was occurred, indicating that the disease was widely distributed in all surveyed districts Table, 7. During farmers pepper field assessments diseased pepper specimens' pathogen were isolated and identified in collaboration with Ambo Plant Protection Research Center.

Table-7. Major pepper diseases identified in the three districts (Jabitahinan, Burie and South Achefer) in 2013/14

No	Disease	Causal organism	Disease type	Distribution
1	Powdery mildew	*Leveillula taurica*	Leaf disease	Medium
2	Bacterial spot	*Xanthomonas campestris*	Leaf disease	Low
3	Wilt/root rot	*Fusarium oxysporum*	Root disease	High

Table, 7 showed that a root disease which is caused by *Fusarium oxysporum* was found with high level of distribution and infection rate.

In Jabitahinan district, Wilt/root rot was highly distributed throughout the surveyed areas followed by powdery mildew and the disease incidence and severity ranged from 30 to 40% and, 20 to 30% and 5 to 10% respectively. Among the three PAs surveyed in this district, higher disease incidence/severity (40.0%) was recorded at Shembekuma for Wilt/root rot and 40% & 10% at Shembekuma for powdery mildew. while the lowest incidence/severity (30.0%) was recorded at Mankusa for wilt/root rot and Mankusa (20%) & Bakel-Abasem (5%) Table, 8.

Table-8. Incidence and severity of pepper diseases in Jabitahinan districts

No	Localities (PAs)	Diseases	Growth stage	Incidence %	Severity %	Remark
1	Shembekuma	Powdery mildew	Flowering-podding	40%	10%	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	40%	40%	
2	Bakel-Abasem	Powdery mildew	Flowering-podding	30%	5%	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	35%	35%	
3	Mankusa	Powdery mildew	Flowering-podding	20%	5%	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	30%	30%	
	Average Incidence			32.50		
	Average Severity				20.83	

In Burie district, Wilt/root rot was also highly distributed throughout the surveyed areas and the disease incidence and severity ranged from 25 to 30%. Among the three PAs surveyed in this district, higher disease incidence/severity (30.0%) was recorded at Allefa-Basi. while the lowest incidence/severity (25.0%) was recorded at Debune fuat and Adelagate respectively Table 9.

Table-9. Incidence and severity of pepper diseases in Burie district

No	Localities (PAs)	Diseases	Growth stage	Incidence %	Severity %	Remark
1	Allefa Basi	Powdery mildew	Flowering-podding	50%	15%	
		Bacterial spot	Flowering-podding	5%	2%	
		Wilt/root rot	Flowering-podding	30%	30%	
2	Debune fuat	Powdery mildew	Flowering-podding	40%	5%	
		Bacterial spot	Flowering-podding	5%	3%	
		Wilt/root rot	Flowering-podding	25%	25%	
3	Adelagate	Powdery mildew	Flowering-podding	20%	5%	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	25%	25%	
	Average Incidence			25%		
	Average Severity				13.8	

In South Achefer district, Wilt/root rot was highly distributed throughout the surveyed areas followed by powdery mildew and the disease incidence and severity ranged from 15 to 20% and, 5 to 10% and 1 to 15% respectively. Among the 3 PAs surveyed in this district, higher disease incidence/severity (20.0%) was recorded at Ahuri for Wilt/root rot and 10% Ahuri for powdery mildew. while the lowest incidence/severity (15.0%) was recorded at all PA's for wilt/root rot Table 10.

Table-10. Incidence and severity of pepper diseases in South Achefer district

No	Localities (PAs)	Diseases	Growth stage	Incidence %	Severity %	Remark
1	Ahuri	Powdery mildew	Flowering-podding	10%	2%	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	20%	20%	
2	Kere	Powdery mildew	Flowering-podding	-	-	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	15%	15%	
3	Abichikli	Powdery mildew	Flowering-podding	5%	1%	
		Bacterial spot	Flowering-podding	-	-	
		Wilt/root rot	Flowering-podding	15%	15%	
	Average Incidence			13		
	Average Severity				10.6	

4. DISCUSSIONS

The educational background of the sample household heads is believed to be an important feature that determines the readiness of household heads to accept new ideas and/or innovations (Abdi *et al.*, 2010). About 43.7% can read and write, whereas 22.9 % joined secondary school. Therefore, the sampled household heads are supposed to accept new ideas. This result is in agreement to the reports of Madisa *et al.* (2010) who in peri-urban vegetable farms of Botswana and Ghana, respectively, found that most vegetable farmers were literate.

The average ages of the sample household heads were in the active age group. It showed that pepper production was mainly conducted by the active age group of the society. This might be due to labor demanding nature of the crop. This is in line with the findings of Madisa *et al.* (2010) who reported that most vegetable farmers were in the active age group. Similarly Fekadu and Dandena (2006) reported that in Ethiopia vegetable crops create employment opportunity.

*Land Allocation of Paper***.** Pepper is cultivated widely in different regions of Ethiopia. According to the Ethiopian Export promotion agency (EEPA, 2003) pepper covered 62 percent of the total area covered by spices in Amhara, Oromiya, and SNNPRS regions. The production was accounted for 34% of the total spices production in the three regions. According to MARC (2005) in recent years the total production has declined due to various reasons, but there is still enormous potential for its production in the country. The current depicted that the land cultivated for pepper production in the year 2012/13 was about 43.33 hectares in all sampled households which is comparable in both areas. An average land holding for all respondents is 0 .36 ha. From the three pepper grower sampled districts, Bure allocated more land than the others. According to the discussant the cultivable land for pepper is reducing because of minimum production.

The primary purpose of red pepper was for marketing (34% farmers), and for marketing and household consumption (63.7% farmers). It shows farmers produce pepper for marketing purpose to increase income. Similar study was conducted by Emana *et al.* (2015) stated that the majority of farmers sell vegetables to generate income to purchase agricultural inputs. During the 2012 production year more than 65% of all major vegetables were sold in the market. This implies that vegetables provide substantial cash income generating opportunity for the farming community to access food (i.e., by selling marketed surplus and buying other foods from the market) for enhanced lively-hoods (Emana *et al.*, 2015). Similarly, Fekadu and Dandena (2006) reported thatin Ethiopia vegetable crops

Provide a source of income for the farmers/producers, and contribute to the national economy as export commodities.

Improved seed is one of the major inputs that affect the production and productivity of crops. Even though about a dozen hot pepper cultivar was released, in Ethiopian pepper research history, two cultivars, namely Marekofana and Bako released in 1976, are being extensively produced in the commercial farms and by the peasant sectors (Alemu and Ermias, 2000). The current showed that the entire sample household used *Marekofana* seed variety from market (merchants) 14%, agricultural office 42.3%, cooperatives 21.5%, and agricultural office and merchant 22.3%. Similar result was reported by Emana *et al.* (2015) inputs, seeds, fertilizer, and pesticides are usually supplied to farmers through farmers' cooperatives/unions, traders, and individual farmers. Most farmers also recycle seeds of specific varieties by saving each season and exchange with other farmers.

Capsicum in the field is established either by direct planting or transplanting depending up on the environmental condition of an area. Both types of planting have their own distinctive advantage or disadvantage over the other (Carter, 1994). The current revealed that 96.2 % of the sampled farmers used transplanting and 3.8 % direct planting method. In spite of the low stand percent, direct sowing was reported to be by far better than transplanting, which is in disagreement to the current. The current was in agreement with the study of Bosland and Votava (2000) which stated that transplanting is used for more precise control of plant population and spacing, thinning, cost avoided, and efficient use of seed (0.8 to 0.9 kg seeds/ha) than direct planting (6.25 kg seeds/ha). According to the discussant transplanting also affords late planting opportunities for seedling raised in green houses and least amount of water during seedling.

Pepper is generally harvested when ripe, but it can also be harvested at a green, immature stage. The same result is reported by Alemnew (2013) which stated that farmers harvest pepper in two forms, green and dried for different purposes. Maturity of green pepper can be based on size, firmness, and color. The current showed that 86.6 % of the sampled farmers used at ripe, and only 13.4 % used at green for market and household consumption.

Various types of vegetable crops are grown in Ethiopia under rain-fed and/or irrigation systems (Alemayehu *et al*., 2010). Vegetables are usually grown in two seasons, namely in the wet season (locally known as Meher season) using rainfall with supplemental irrigation or under full irrigation during the dry season (Emana *et al*., 2015). For high yields, an adequate water supply and relatively moist soils are required during the entire growing season. Hot pepper are usually grown in two seasons, namely in the wet season using rainfall with supplemental irrigation or under full irrigation during the dry season (Emana *et al*., 2015). The current depicted similar results, sample farmers have used different methods of pepper production such as by using rain and irrigation. The current showed that 73.3% of the sampled farmers produced by using rain from these farmers 32.5% were from Jabitahinan district. Irrigation method of production used by 2.9% of the sampled farmers from Jabitahinan and South Achefer districts while 22.9 % have used rainy and irrigation which included Bure and South Achefer districts, but this study was against the study of Alemnew (2013) which stated that all the sampled farmers in Bure district produces red pepper using rain fed agriculture.

Access to agricultural extension service enhances production and productivity of pepper thereby increasing marketable surplus and farm income. The current showed that 91.8% of the total sampled household had extension contact in relation to pepper production, similar result was reported by Alemnew (2013) explained that 95% of sampled households had contact with development agents in relation to pepper production in Bure district.

The current depicted that about 73.4% of the respondents pointed out that they need credit and 75.7% of them had received credit. More of the Bure farmers 41.4% needed credit than other districts farmers and 48% received credit but this study was in disagreement with the study of Alemnew (2013) revealed that 16% of Bure producers farmers had access to credit.

4.1. Distribution, Incidence and Severity of Pepper Diseases in Surveyed Areas of West Gojam Zone

In all assessed fields root rot/wilt was found to be occurred, indicating that the disease was widely distributed in all surveyed districts this result was in line with Mekdes *et al.* (2018) in Mareko district, Southern region, which reported that based on its occurrence, the most commonly occurred diseases were root rot disease and it influenced the quantity of supply of red pepper to the market negatively. A root disease which is caused by *Fusarium oxysporum* was found with high level of distribution and infection rate. The work done by Merkuz and Getachew (2012) also reported that the particular pathogen is dominantly found in Amhara Region on chickpea.

In Jabitahinan district, Wilt/root rot was highly distributed throughout the surveyed areas followed by powdery mildew and the disease incidence and severity ranged from 30 to 40% and, 20 to 30% and 5 to 10% respectively. Among the three sampled districts, higher disease incidence/severity (40.0%) was recorded at Shembekuma for Wilt/root rot and 40% and 10% at Shembekuma for powdery mildew. The result also agrees with that of Merkuz and Getachew (2012) report on chickpea wilt/root rot.

In Burie district, Wilt/root rot was highly distributed throughout the surveyed areas and the disease incidence and severity ranged from 25 to 30%. Among the three sampled districts, higher disease incidence/severity (30.0%) was recorded at Allefa-Basi, while the lowest incidence/severity (25.0%) was recorded at Debune fuat and Adelagate respectively. The work is agree with that of survey report of BPHC (Bahir Dar Plant Health Clinic) (2000) which indicated powdery mildew is one of the major disease of pepper in west-Amhara.

In South Achefer district, Wilt/root rot was highly distributed throughout the surveyed areas followed by powdery mildew and the disease incidence and severity ranged from 15 to 20%, and 5 to 10% and 1 to 15% respectively. Among the 3 sampled districts, higher disease incidence/severity (20.0%) was recorded at Ahuri for Wilt/root rot and 10% Ahuri for powdery mildew. while the lowest incidence/severity (15.0%) was recorded at all PA's for wilt/root rot. Similar report was done also reported of Fusarium on chick pea and powdery mildew on pepper in Amhara Region (BPHC, 2000; Abera *et al.*, 2011; Merkuz and Getachew, 2012).

5. CONCLUSIONS

Like other major spices, the production and productivity of hot/red pepper in Ethiopia has increased to a large extent over the years due to its growing importance in both domestic and international markets. However, pepper has very unsure distinction as the yield of this crop has not improved appreciably during the past five years. This paper focused on Pepper Disease Assessment and Identification in major growing districts of West Gojam zone in northwestern, Ethiopia. For this study, a total of 135 respondents were interviewed using semi-structured interview schedule. Rapid pepper disease appraisal with focus group discussion, and key informant interview was also conducted.

From the three pepper grower sampled districts, Bure allocated more land for paper production than the others. The average years of farming experience for total sampled household were 24 years. The primary purpose of red pepper in the study area was for marketing 34%. The entire sampled household used Marekofana seed variety. Red pepper in the field is established either by direct planting or transplanting depending upon the environmental condition of an area, 96.2 % of the sampled farmers transplants the seedlings. 73.3% of the sampled farmers produced pepper by using rain.77.8% of sampled farmers store hot/red pepper for different purposes such as expecting future increase in price, low demand during harvest, and consumption. About 88.5% of the total sampled households put their pepper by filling in sack and placing it at *'kot'* (shelf), whereas 11.4% of the sampled households placed in *gottera.* 98.1% of the total sampled household had extension contact in relation to pepper production. About 73.4% of the respondents need credit and 75.7% of them had received credit.

The current result shows out of the identified diseases from the collected damage specimens pepper wilt/root rot caused by *Fusarium oxysporum* to be an important disease and caused heavy reduction in the yield of pepper in the surveyed areas. In addition to yield reduction, it also adversely affected the quality of pepper, the affected pods

will gradually change to white, mixes with the normal one during time of harvesting. This disease was also found to be prevalent in all the surveyed localities dominantly on the variety Markofana. Furthermore, other leaf diseases which were categorized during survey time as minor did not mean not affecting the yield of pepper.

Generally from the survey it was understood that the wide distribution and severity of the disease that of wilt/root rot is economically important. Finally, it can be concluded monitoring of the pepper disease is crucial for the good yield of pepper in the zone. Therefore, efforts should be made towards the integration of multiple control options. These are development of resistance varieties with all its recommendation, implementation of improved agronomic practices, awareness creation, and training of farmers from site selection up to post harvest handling on the importance of diseases and their management. In general, holistic cumulative integrated approach is required in all exigencies to manage the complex diseases developed in the region.

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