

Survey and Identification of Rice Diseases in South Gondar Zone, Amhara Region, Ethiopia

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Abstract

Disease surveys were conducted in rice grown districts of Libokemkem, Dera and Fogera in south Gondar zone in 2016 and 2017 cropping seasons. The study was designed to identify and record rice disease flora, their distribution in the districts, prioritize according to the importance and document for future use. Forty-six and 48 rice fields were assessed from nine Peasant Association (PA) in 2016 and 2017 cropping seasons, respectively. Rice diseases; Leaf blast, Panicle Blast, Brown spot, Sheath rot, Sheath brown rot, Sheath Blight, Bacterial blight, Rice Yellow Motile Virus, Kernel smut, Downy mildew were identified in 2016 cropping season and nine rice diseases: Leaf blast, Panicle Blast, Neck Blast, Node blast, Brown spot, Sheath rot, Sheath brown rot, Rice Yellow Motile Virus, Kernel smut were identified in 2017. The overall mean prevalence of sheath rot and sheath brown rot diseases were above 60%, while the others had prevalence below 21%. The incidences and severities of these two diseases were higher than the other diseases implying that both diseases were important. In the present studies many rice diseases were recorded in lowland ecosystem as compared to upland ecosystem. From the assessment X-jigna cultivar was more susceptible to rice disease and followed by Gumera. The results indicate that a sheath rot, and sheath brown rot, were important across the districts and years. Loss assessment studies should be initiated in order to know the yield damage caused by the diseases.

Keywords: *Oryza sativa*; Prevalence; Incidence; Severity; Upland; Lowland; Ecosystem.



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1. Introduction

Rice, *Oryza sativa* L. is an important crop worldwide, serving as the staple food for half of humanity and additionally being used in industry and for animal feed. Rice is grown in various agro-ecological zones in tropical and subtropical areas, especially in Asia, the continent accounting for 90% of the world production [1]. Rice is becoming one of the major crops and plays a significant role in contributing to food security, income generation, poverty alleviation and in socio economic growth of Ethiopia [2]. It is introduced to Ethiopia in 1970s which is a recent phenomenon to Ethiopia. Efforts to introduction of rice had probably been started in Ethiopia when the wild rice (*O. longistaminata*) was observed in the swampy and waterlogged areas of Fogera and Gambella Plains [3].

Rice production in Ethiopia is proved to have reasonable potential to grow different rice types for rainfed lowland, upland, and irrigated ecosystems. Accordingly, CSA report in 2018 total cultivated area 53106.8 ha, total production 151018.3ton and productivity 2.844 ton/ha in 2017/18 of cropping seasons at national level, while in Amhara region the total cultivated land 3982.9ha, total production 118030.9 ton and productivity average 2.963ton/ha. The 78% of the total production for the country was obtained from the Amhara region and the potential productivity of average was also excel the national average by 4.2% in the 2017/18 of cropping seasons. Rice is the second rank after maize in terms of productivity among cereals both at national and regional level which proved as it will play a significant role for food security in Ethiopia [4].

However, still rice remains as a minor crop in Ethiopia both in area coverage and production compared to a large area and favorable agro-climatic conditions for rice production in the country. The production was tackled by cumulative effect of different biotic and abiotic constraints, rice disease and pests have been identified as leading constraints in the country and farmers lose an estimated average of 37% of their rice crop to pests and diseases every year [5].

Information on rice diseases, and yield losses due to the diseases were not extensive and quantitative in South Gondar zone of Amhara Region of Ethiopia. The biotic (disease) stresses in the area increased as production area coverage, demand of rice for food security and demand of market in the country increased by the import substitution [6].

Therefore, the objectives of the study were on documentation and identification of different groups of rice diseases (fungal, bacterial and virial) in different rice production ecosystems and rice commercial cultivars reaction

to various disease helps to identify research gaps, improve and disease management strategies for rice production system.

2. Materials and Methods

2.1. Study Areas and Sampling Methods

Rice diseases surveys were conducted in 2016 and 2017 cropping seasons in three major rice producing districts of Libo kemkem, Fogera and Dera in south Gonder zone of Amhara region. To assess the rice diseases from Peasant Associations (PA) located in the districts were selected randomly. The fields were sampled following the main roads and accessible routes in the selected PAs, and stops were made at every 2-4 km intervals based on vehicles odometers. The sampling method in the rice farm was based by walking in “W” patterns using quadrant of 0.5m x 0.5m by tossing 4-6 times in each rice farm. The assessment was conducted on 46 and 48 rice fields during the main cropping seasons (rain-fed) in 2016 and 2017, respectively (Table 1).

Table-1. Selected Districts, PAs, number of fields and altitudes of rice disease surveyed areas in the south Gondar, 2016-2017

Districts	PAs	2016		2017	
		No. field assessed	Altitude (m)	No. field assessed	Altitude
Libo kemkem	Bura	8	1798 -1825	3	1798 -1804
	Shina	5	1791 -1799	6	1797 -1799
Fogera	Awo Kokit	3	1800 -1802	4	1794 -1795
	Tiwa Zakuna	4	1793 -1798	7	1794 -1802
	Diba Sifatira	3	1829 -1832	-	-
	Kuar Mikael	6	1796 -1802	7	1796 -1806
	Kuar Abow	-	-	5	1796 -1807
	Woreta zuria	6	1796 -1822	3	1805 -1814
	Shina tsion	3	1796 -1797	-	-
Dera	Jigna	4	1801 -1806	7	1796 -1805
	Zara	4	1785 -1800	6	1795 -1812
Total		46		48	

*PAs = Peasant Association (kebele)

2.2. Disease Identification

The identifications were conducted based on previously suggested information in the field guide of rice disease accordingly by Hodgson, *et al.* [7], and additionally based on the different literatures that was cited in the result and discussion parts of this papers. The disease samples from different parts of rice were collected for difficulty to identify by using the symptoms through rice field guide in the field was brought to phytopathology laboratory for further diagnosis.

2.3. Rice Disease Assessment

The disease prevalence was calculated using the number of fields affected divided by the total number of fields assessed and expressed in percentage. Incidence was calculated by using the number of plants infected and expressed as percentage of the total number of plants assessed. Severity was scored and calculated by area of rice plant parts affected by total area of plant parts examined.

$$\text{Disease Incidence (\%)} = \frac{\text{Number of infected plant}}{\text{Total plants examined}} \times 100 \quad (1)$$

$$\text{Disease severity (\%)} = \frac{\text{Area of plant tissue affected}}{\text{Total area of plant parts affected}} \times 100 \quad (2)$$

$$\text{Disease prevalence (\%)} = \frac{\text{Number of fields affected by disease}}{\text{Total number of field assessed}} \times 100 \quad (3)$$

The incidence and severity of rice diseases were recorded for each field. Field data scoring sheet were also developed to record planting methods, crop stage, rice ecosystem and type of varieties cultivated. The geographic coordinates (latitude and longitude), and altitude were recorded using Geographic Positioning System (GPS) unit. Any unknown disease samples were collected and put in paper bags for further inspection in the laboratory. To obtain the variation between the surveyed diseases, descriptive statistics was used.

3. Results and Discussions

In the two consecutive years of 2016 and 2017 cropping seasons, intensive diseases assessments were conducted from the three districts of Libokemkem, Fogera and Dera in South Gondar zone of Amhara regional states of Ethiopia. During the assessments about 12 types of diseases were identified in rice fields. All diseases identified are foliar diseases that were caused by either fungal, bacterial or viral diseases. Among the inspected fields, eight fungal: Leaf blast (*Pyricularia oryzae*), Panicle Blast (*P. oryzae*), Neck Blast (*P. oryzae*), Node blast (*P. oryzae*), Brown

spot (*Drechslera oryzae*), Sheath rot (*Sarocladium oryzae*), Sheath Blight (*Rhizoctonia solani*), Kernel smut (*Tilletia barclayana*) and Downy mildew (*Sclerophthora macrospora*), two bacterial: Bacterial blight (*Xanthomonas oryzae pv oryza*) and sheath brown rot (*Pseudomonas fuscovaginae*) and one viral disease: Rice Yellow Motile Virus (RYMV) were identified. The prevalence, incidence and severity of rice diseases varied from season to season, within rice production system (upland and lowland rice) and the rice varieties grown. Some rice varieties are particularly subject to outbreaks of diseases while others are more resistant to them. In the present study the prevalence, incidence, severity of diseases, cultivar reaction and responses of rice production ecosystem results were presented in the following Table 2, 3, 4, 5, 6.

3.1. Assessments of Rice Diseases in South Gondar Zone

The highest disease prevalence was recorded in sheath brown rot (77%), sheath rot (61%) and followed by brown spot (42%) from libokemkem district. In Fogera District, sheath rot (73%), sheath brown rot (60%), leaf blast (25%), panicle blast (23%) and neck blast (24%) were among the dominant diseases identified in rice farms fields. Diseases like node blast, Brown spot, sheath blight, Rice Yellow Motile Viruses (RYMV) and kernel smut were identified as minor diseases in the rice farms of Fogera plane. In Dera district also, sheath rot (74%), sheath rot (43%), brown spot (21%) and panicle blast (28%) had shown the maximum percentage of prevalence. Overall mean prevalence of sheath rot, sheath brown rot, brown spot, panicle blast, neck blast diseases were 69%, 60%, 21%, 17% and 15%, respectively (Table 2). The least three prevalence of 4% or less were noted by bacterial blight, node blast and rice yellow motile virus and downy mildew diseases.

Table-2. Prevalence of rice diseases in three districts of south Gondar zone of Amhara region

District	years	Rice disease											
		LB	PB	NeB	NoB	BS	SR	SBR	SB	BB	RYMV	KS	DM
Libo kemkem	2016	0	0	0	0	10	22	62	17	0	0	0	0
	2017	0	0	0	0	75	100	92	0	0	0	9	0
	means	0	0	0	0	42	61	77	8	0	0	4	0
Fogera	2016	22	24	0	0	0	62	50	13	0	0	7	0
	2017	28	22	48	7	30	83	69	0	0	8	21	0
	means	25	23	24	4	15	73	60	7	0	4	14	0
Dera	2016	19	44	0	0	0	81	31	11	8	11	11	25
	2017	7	11	41	7	9	67	56	0	0	0	4	0
	means	13	28	21	4	5	74	43	6	4	6	7	13
Overall means		13	17	15	3	21	69	60	7	1	3	8	4

*LB=Leaf blast, PB=Panicle Blast, NeB=Neck Blast, NoB=Node blast, BS=Brown spot, SR=Sheath rot, SBR=Sheath brown rot, SB= Sheath Blight, BB=Bacterial blight, RYMV=Rice Yellow Motile Virus, KS=Kernel smut, DM= Downy mildew

The disease of 19%, 23% and 16% in sheath rot, sheath brown rot and brown spot from Libokemkem; 40%, 28%, 18%, 12% and 11% in sheath rot, sheath brown rot, leaf blast, brown spot and panicle blast from Fogera district and 46%, 28%, 27%, 23%, 15% in sheath rot, sheath brown rot, panicle blast, brown spot and leaf blast from Dera district, respectively had recorded the maximum incidences (Table 3).

Table-3. Incidences of rice diseases in three districts of south Gondar zone of Amhara region

Districts	years	Rice Diseases											
		LB	PB	NeB	NoB	BS	SR	SBR	SB	BB	RYMV	KS	DM
Libo Kemkem	2017	0	0	0	0	13	20	18	0	0	0	3	0
	2016	0	0	0	0	19	19	28	5	0	0	0	0
	Means	0	0	0	0	16	19	23	2	0	0	1	0
Fogera	2017	13	6	6	1	24	33	26	0	0	12	2	0
	2016	22	15	0	0	0	47	30	8	0	12	16	0
	Means	18	11	3	0	12	40	28	4	0	12	9	0
Dera	2017	7	4	14	2	46	46	36	0	0	0	6	0
	2016	24	49	0	0	0	45	21	4	38	0	0	11
	Means	15	27	7	1	23	46	28	2	19	0	3	5
Overall Mean		11	12	3	0	17	35	26	3	6	4	4	2

*LB=Leaf blast, PB=Panicle Blast, NeB=Neck Blast, NoB=Node blast, BS=Brown spot, SR=Sheath rot, SBR=Sheath brown rot, SB= Sheath Blight, BB=Bacterial blight, RYMV=Rice Yellow Motile Virus, KS=Kernel smut, DM= Downy mildew

Finally, kernel smut (25%), sheath brown rot (18%), sheath rot (15%) and brown spot (12%) in libokemkem district, sheath rot (38%), Neck blast (30%), Panicle blast (30%), kernel smut (30%), sheath brown rot (23%), brown spot (12%), leaf blast (16%) and RYMV (15%) in Fogera and sheath rot (30%), sheath brown rot (14%), panicle blast (18%), neck blast (17%), bacterial blight(11%) and RYMV (13%) disease form Dera district scored the highest rice severities (Table 4). The overall means rice disease incidences and severities over the three surveyed districts and two years showed similar pattern to the prevalence of rice disease scored.

A large number of diseases were identified from Dera district, and then from Fogera and a smaller number of diseases from libokemkem districts were identified. *Sarocladium oryzae*, sheath rot is the major fungal pathogen over the three districts and two years.

Table-4. Severities of rice diseases in three districts of south Gonder zone of Amhara region

Districts	years	Rice disease											
		LB	PB	NeB	NoB	BS	SR	SBR	SB	BB	RYMV	KS	DM
Libo kemkem	2017	0	0	0	0	13	19	20	0	0	0	50	0
	2016	0	0	0	0	10	11	16	6	0	0	0	0
	Means	0	0	0	0	12	15	18	3	0	0	25	0
Fogera	2017	16	48	60	9	24	43	25	0	0	28	50	0
	2016	16	11	0	0	0	33	20	10	0	1	10	0
	Means	16	30	30	5	12	38	23	5	0	15	30	0
Dera	2017	6	6	33	4	22	27	16	0	0	0	33	0
	2016	14	30	0	0	0	33	11	4	22	26	11	4
	Means	10	18	17	2	11	30	14	2	11	13	22	2
Overall means		9	16	16	2	12	28	18	3	4	9	26	1

*LB=Leaf blast, PB=Panicle Blast, NeB=Neck Blast, NoB=Node blast, BS=Brown spot, SR=Sheath rot, SBR=Sheath brown rot, SB= Sheath Blight, BB=Bacterial blight, RYMV=Rice Yellow Motile Virus, KS=Kernel smut, DM= Downy mildew

3.1.1. Sheath Rot Disease

The major symptoms caused by sheath rot on rice are described according to Ou [8]: the rot occurs on the uppermost leaf sheaths enclosing the young panicles; the lesions start as oblong or somewhat irregular spots with brown margins and gray centers, the young panicles remain within the sheath or only partially emerge (figure 1). It is infection results in chaffy, discolored grains, and affects the viability and nutritional value of seeds [9, 10].

Figure-1. Symptoms of sheath rot disease in rice field



3.1.2. Sheath Brown Rot Disease

In the present study, the other widely distributed disease next to sheath rot was the sheath brown rot, *Pseudomonas fuscovaginae*. Sheath brown rot symptoms appear on rice plants at seedling and later growth stages.

Infected seedlings initially show yellow to brown discoloration on the lower leaf sheath [11, 12]. The discoloration later turns grey-brown to dark-brown. Symptoms of mature-plant infection as older lesions may be surrounded by an effuse, dark-brown margin. The leaf sheath may also display general water-soaking and necrosis without distinct lesions (Figure 2).

Figure-2. Symptoms of sheath brown rot disease in rice field



3.1.3. Blast Disease in Rice

Neck blast and node blast are characterized as brown color and rot symptom that affects and disorganizes the tissues of rice stem and prevents the migration or translocation prepared food and minerals that should ensure grain filling to contribute for increasing yield. This leads to early maturity of the panicles, causing indirect and seldom quantified yield losses through grain shedding. Neck blast is considered more destructive than leaf blast, because it is more closely tied to yield losses [13].

Figure-3. Symptoms of Panicle blast (A), Neck blast (B), Node blast (C), Leaf blast (D) disease in rice field



3.1.4. Brown Spot Disease

Brown spot is a fungal disease that infects all parts of plant. Its most observable damage is the numerous big spots on the leaves which can kill the whole leaf. When infection occurs in the seed, unfilled grains or spotted or discolored seeds are formed. Infected seedlings have small, circular, yellow brown or brown lesions that may girdle the coleoptile and distort primary and secondary leaves. Starting at tillering stage, lesions can be observed on the leaves. They are initially small, circular, and dark brown to purple-brown. Fully developed lesions are circular to oval with a light brown to gray center, surrounded by a reddish-brown margin caused by the toxin produced by the fungi [1].

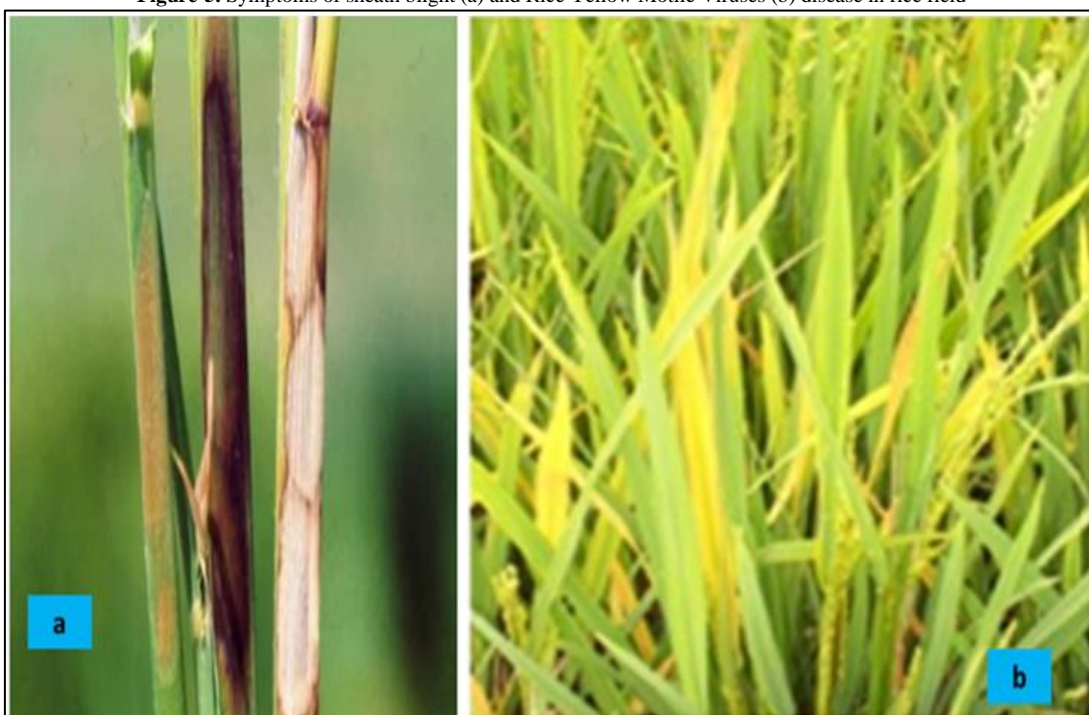
Figure-4. Symptoms of Brown spot disease in rice field



3.1.5. Rice Yellow Motile Viruses (RYMV)

Rice yellow mottle virus (RYMV, genus *Sobemovirus*) with leaf yellowing and mottling symptoms (Figure 5) were observed in Fogera and Dera districts during a joint survey of scientists from Madagascar (FOFIFA), Ethiopian Institute of Agricultural Research (EIAR), and Japan International Cooperation Agency (JICA) in 2013. Samples collected from causing small patches of infected rice fields and was sent to Madagascar laboratory to diagnosis or detecting the presence of viral infection in rice crop, indicating that for the first time the presence of the virus in rice from Ethiopia [14].

Figure-5. Symptoms of sheath blight (a) and Rice Yellow Motile Viruses (b) disease in rice field



3.2. Response of Cultivars to Major Rice Diseases

Rice varieties; Nerica-4, X-jigna, Gumera, Hibiri, edeget and Demoz were cultivated or grown in surveyed districts of south Gondar zone. Among those, X-jigna (the old) is one of the most popularly grown cultivars and followed by Gumera, Hibiri and Nerica-4. More number of diseases were recorded on X-jigna and less on Gumera cultivar. The maximum of sheath rot severity (46%) and incidence (43%), sheath brown rot severity (38%) and incidence (46%) disease were recorded on X-jigna cultivar. Therefore, cultivars X-jigna and Gumera were susceptible to all identified diseases. The brown spot, sheath brown rot and sheath rot of rice affect Nerica-4 and Demoz (name was given by farmers and farmers improved variety) cultivars. In this way, the response of Nerica-4 cultivar was identified as resistance to all diseases except brown spot, sheath brown rot and sheath rot (Table 5).

Table-5. Response of rice cultivars to disease severity and incidence in South Gondar zone, Amhara regions in 2016 and 2017 main cropping seasons

S/ N	Disease	Rice cultivars									
		NERICA 4		X-Jigna		Gumara		Hibir		Demoze	
		DI	DS	DI	DS	DI	DS	DI	DS	DI	DS
1	Leaf blast	0	0	30	26	10	11	48	28	0	0
2	Panicle blast	0	0	22	41	33	49	48	33	0	0
3	Neck blast	0	0	12	62.2	17.5	59.3	0	0	0	0
4	Node blast	0	0	2.9	22.2	0	0	0	0	0	0
5	Brown spot	23.1	15	11	11	36	25	0	0	5	11
6	Sheath brown rot	19.6	14	33	24	45	31	0	0	20	11
7	Sheath rot	15.4	11	50	43	46	38	44	34	50	44
8	Sheath blight	0	0	14	15.3	5	11.1	0	0	0	0
9	Kernel smut	0	0	18	65	0	14	0	0	0	0
10	Downy mildew	0	0	0	0	21	11	21	11	0	0
11	Bacterial blight	0	0	21	17.9	0	0	0	0	0	0
12	Rice Yellow Motile Virus	0	0	0	0	30	25	22	12	0	0

*DI = Disease Incidence, DS = Disease severity

3.3. Effect of Rice Ecosystem to major Rice Disease

The assessment of rice diseases in rice production area of south Gondar zone identified two rice production ecosystems (upland and lowland) under rain fed conditions (Table 6). The lowland ecosystem was the dominant rice ecosystem from surveyed districts when compared to upland ecosystem. Total of 12 diseases were recorded in the lowland ecosystem, whereas 8 diseases were from the rice upland ecosystem. The maximum RYMV incidence of 90% and severity of 47% were recorded from low land ecosystem. The Neck blast, Node blast, sheath blight and Bacterial leaf blight diseases were not recorded in the upland rice ecosystem. Rice blast is a major disease in the upland and lowland ecosystem in south Gondar zone. Crop losses attributed to rice blast vary according to localities and yield losses of up to 100% have been observed in some locations in Gambia [15]. The report of rice blast economic importance and distribution in all rice-growing countries worldwide, being very common in rainy seasons [16] and both in upland and lowland ecologies/ecosystem. It has so far been reported in the following countries [17]: Bangladesh, Brunei Darussalam, China, India, Indonesia, Japan, Malaysia, Nepal, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Tajikistan, Thailand, Uzbekistan, Vietnam, Burundi, Cameroon, Côte d'Ivoire, Gambia, Kenya, Madagascar, Niger, Nigeria, Senegal, Tanzania, Mexico, USA, Argentina, Brazil, Venezuela, and Australia. *S. oryzae* is mostly found in lowland environments [18].

Table-6. Response of Rice ecosystem to Disease severity and incidence in South gondar zone, Amhara regions in 2016 and 2017 main cropping seasons

S/N	Disease	Rice Ecosystem			
		lowland		Upland	
		DI	DS	DI	DS
1	Leaf blast	26	23	45	30
2	Panicle blast	56	9	37	28
3	Neck blast	61	14	0	0
4	Node blast	22	3	0	0
5	Brown spot	24	20	17	11
6	Sheath rot	30	26	32	24
7	Sheath brown rot	30	23	24	16
8	Sheath blight	14	12	0	0
9	Kernel smut	73	7	37	32
10	Downy mildew	14	11	21	11
11	Bacterial blight	18	21	0	0
12	Rice Yellow Motile Virus	90	47	43	41

4. Conclusions

During the Rice disease surveys of 2016 and 2017 main cropping seasons, totally eleven PAs from the three potential rice production districts were assessed to report the microflora of disease for further intervention of the most economic important ones in farmers field. Over 94 farmers' fields were assessed from both cropping seasons and collected samples from different plant parts damaged by diseases were brought to laboratory for further diagnosis. Among totally twelve (12) rice disease identified eight fungal diseases; Brown spot, sheath rot, leaf blast, panicle blast, neck blast, node blast, sheath blight and kernel smut, two bacterial leaf blight and sheath brown rot, disease and one viral disease, Rice Yellow Motile Virus (RYMV).

The fungal diseases like sheath rot, sheath brown rot and blast (panicle and leaf) diseases are the most frequently encountered diseases in surveyed area. In the future efforts should be made towards the integration of multiple control options like development of resistance varieties, development of improved agronomic practices, awareness creation among farmers and experts. The yield loss caused by each pathogen type should be clearly studied and quantified in the rice crop. In the mid-term plan (10 years) of crop protection rice strategies in Ethiopia was defined to the important of mapping hot spot areas for major diseases, estimating the losses caused by the economic disease in the production areas, generating information on epidemiology and race identifications, study the virulence of different races of the pathogens, identify indigenous knowledge on rice pest control methods, identifying effect of nitrogen level and other soil nutrients in relation with rice diseases. Identify resistant rice varieties/germplasms against major rice diseases, manipulate cultural practices to reduce the incidence and severity of pests, identify natural enemies/biological control, identify effective chemical control, strength quarantine and regulatory control system.

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